

Cyclopenta[b]naphthalene derivatives

5 The present invention relates to cyclopenta[b]naphthalene derivatives, to the use thereof in liquid-crystalline or mesogenic media, to liquid-crystalline or mesogenic media comprising these derivatives, and to electro-optical display elements containing these liquid-crystalline or mesogenic media.

Liquid crystals have found widespread use since the first commercially usable liquid-crystalline compounds were found about 30 years ago. Known areas of application are, in particular, displays for watches and
10 pocket calculators, and large display panels as used in railway stations, airports and sports arenas. Further areas of application are displays of portable computers and navigation systems and video applications. For the last-mentioned applications in particular, high demands are made of the response times and contrast of the images.

15 The spatial arrangement of the molecules in a liquid crystal has the effect that many of its properties are direction-dependent. Of particular importance for use in liquid-crystal displays are the optical, dielectric and elasto-mechanical anisotropies. Depending on whether the molecules are oriented with their longitudinal axes perpendicular or parallel to the two
20 plates of a capacitor, the latter has a different capacitance; in other words, the dielectric constant ϵ of the liquid-crystalline medium has different values for the two orientations. Substances whose dielectric constant is larger in the case of a perpendicular orientation of the longitudinal axes of
25 the molecules to the capacitor plates than in the case of a parallel arrangement are referred to as dielectrically positive. Most liquid crystals used in conventional displays fall into this group.

30 Both the polarisability of the molecule and permanent dipole moments play a role for the dielectric anisotropy. On application of a voltage to the display, the longitudinal axis of the molecules orients itself in such a way that the larger of the dielectric constants becomes effective. The strength of the interaction with the electric field depends on the difference between the two constants. In the case of small differences, higher switching voltages
35 are necessary than in the case of large differences. The incorporation of suitable polar groups, such as, for example, nitrile groups or fluorine, into

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the liquid-crystal molecules enables a broad range of working voltages to be achieved.

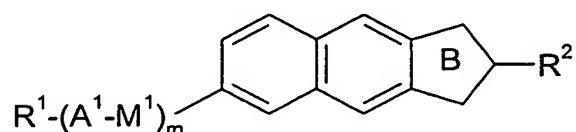
5 In the case of the liquid-crystalline molecules used in conventional liquid-crystal displays, the dipole moment oriented along the longitudinal axis of the molecules is larger than the dipole moment oriented perpendicular to the longitudinal axis of the molecules. The orientation of the larger dipole moment along the longitudinal axis of the molecule also determines the orientation of the molecule in a liquid-crystal display in the field-free state. In the most widespread TN ("twisted nematic") cells, a liquid-crystalline layer with a thickness of only from about 5 to 10 μm is arranged between two flat glass plates, onto each of which an electrically conductive, transparent layer of tin oxide or indium tin oxide has been vapour-deposited as electrode. A likewise transparent alignment layer, which usually consists of a plastic (for example polyimides), is located between these films and the liquid-crystalline layer. This alignment layer serves to bring the longitudinal axes of the adjacent crystalline molecules into a preferential direction through surface forces in such a way that, in the voltage-free state, they lie uniformly on the inside of the display surface with the same orientation in a flat manner or with the same small tilt angle. Two polarisation films which only enable linear-polarised light to enter and escape are adhesively bonded to the outside of the display in a certain arrangement.

By means of liquid crystals in which the larger dipole moment is oriented parallel to the longitudinal axis of the molecule, very high-performance displays have already been developed. In most cases here, mixtures of from 5 to 20 components are used in order to achieve a sufficiently broad temperature range of the mesophase and short response times and low threshold voltages. However, difficulties are still caused by the strong viewing-angle dependence in liquid-crystal displays as are used, for example, for laptops. The best imaging quality can be achieved if the surface of the display is perpendicular to the viewing direction of the observer. If the display is tilted relative to the observation direction, the imaging quality drops drastically under certain circumstances. For greater comfort, attempts are being made to make the angle through which the display can be tilted from the viewing direction of an observer as large as possible. Attempts have recently been made to improve the viewing-angle

- 3 -

dependence using liquid-crystalline compounds whose dipole moment perpendicular to the longitudinal axis of the molecules is larger than that parallel to the longitudinal axis of the molecule. In the field-free state, these molecules are oriented perpendicular to the glass surface of the display. In this way, it has been possible to achieve an improvement in the viewing-angle dependence. Displays of this type are known as VA-TFT ("vertically aligned") displays.

DE 44 34 974 A1 discloses tricyclic compounds of the general formula

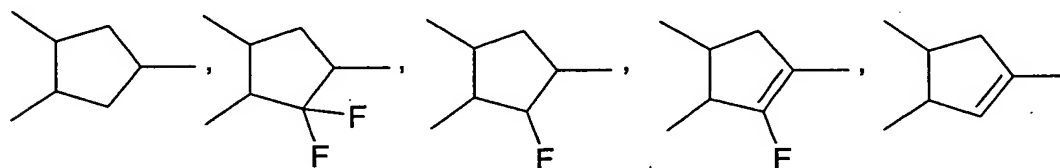


in which the symbols and indices have the following meanings:

R^1 is -F, -CN, -Cl, -CF₃ or has, independently of R^2 , one of the meanings mentioned for R^2 ;

R^2 is H or a straight-chain or branched alkyl radical having from 1 to 20 carbon atoms (with or without an asymmetrical carbon atom), in which, in addition, one or more -CH₂- groups (but not those bonded directly to the five-membered ring) may be replaced by -O-, -S-, -CH=CH-, -C≡C-, cyclopropane-1,2-diyl, -Si(CH₃)₂-, 1,4-phenylene, 1,4-cyclohexylene, 1,3-cyclopentylene, 1,3-cyclobutylene, 1,3-dioxane-2,5-diyl, with the proviso that oxygen atoms and sulfur atoms must not be bonded directly, and in which, in addition, one or more H atoms of the alkyl radical may be substituted by F, Cl, Br or OR³, or an optically active or racemic group;

Ring B is



- 4 -

A¹ is 1,4-phenylene, 1,4-cyclohexylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, 1,3-thiazole-2,5-diyl, 1,3-thiazole-2,4-diyl, in which, in addition, one or more hydrogens may be substituted by F, 1,3,4-thiadiazole-2,5-diyl;

5 M¹ is a single bond, -C≡C-, -CH₂CH₂-, -O-CO-, -CO-O-, -CO-, -OCH₂-, -CH₂O- or -O-CO-O-; and m is zero or one.

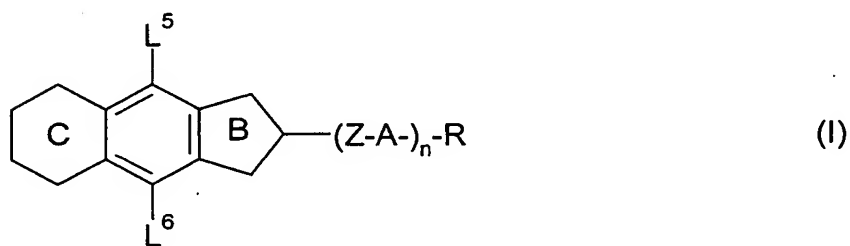
However, the Δε of the compounds disclosed in this document is not sufficient to ensure satisfactory properties, for example in VA-TFT displays.

10 Development in the area of liquid-crystalline materials is far from complete. In order to improve the properties of liquid-crystalline display elements, attempts are constantly being made to develop novel compounds which enable such displays to be optimised.

15 An object of the present invention was to provide compounds having advantageous properties for use in liquid-crystalline media.

This object is achieved in accordance with the invention by cyclopenta[b]-naphthalene derivatives of the general formula (I)

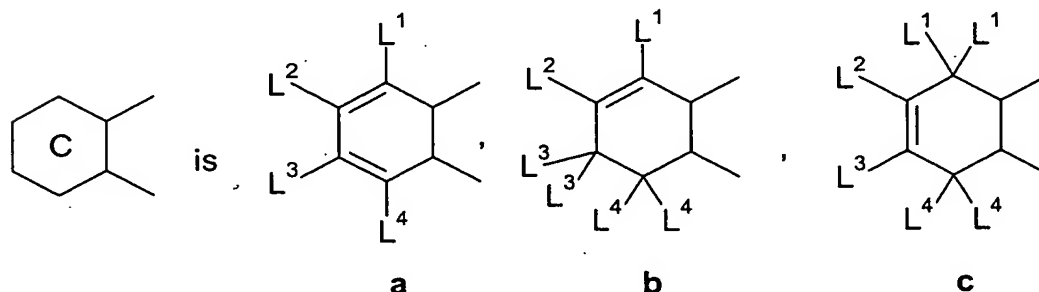
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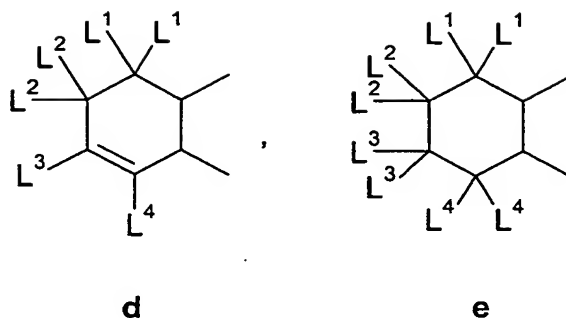
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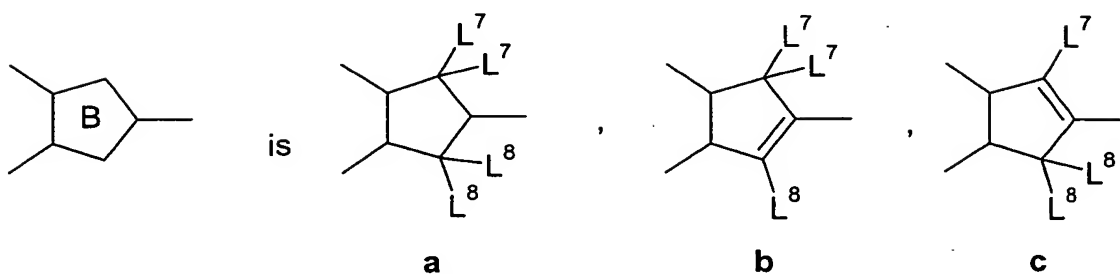
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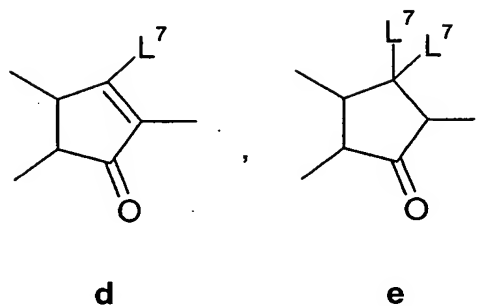


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Z is in each case, independently of one another, a single bond, a double bond, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CF}_2\text{CF}_2-$, $-\text{C}(\text{O})\text{O}-$, $-\text{OC}(\text{O})-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CF}=\text{CH}-$, $-\text{CH}=\text{CF}-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CH}-$ or $-\text{C}\equiv\text{C}-$,

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A is in each case, independently of one another, 1,4-phenylene, in which $=\text{CH}-$ may be replaced once or twice by $=\text{N}-$, and which may be monosubstituted to tetrasubstituted, independently of one another, by halogen ($-\text{F}$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$), $-\text{CN}$, $-\text{CH}_3$, $-\text{CH}_2\text{F}$, $-\text{CHF}_2$, $-\text{CF}_3$, $-\text{OCH}_3$, $-\text{OCH}_2\text{F}$, $-\text{OCHF}_2$ or $-\text{OCF}_3$, 1,4-cyclohexylene, 1,4-cyclohexenylene or 1,4-cyclohexadienylene, in which $-\text{CH}_2-$ may be replaced once or twice, independently of one another, by $-\text{O}-$ or $-\text{S}-$ in such a way that heteroatoms are not directly adjacent, and

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which may be monosubstituted or polysubstituted by halogen, or is 1,3-cyclobutylene or bicyclo[2.2.2]octane,

R is hydrogen, an alkyl, alkoxy, alkenyl or alkynyl radical having from 1 to 15 or 2 to 15 carbon atoms respectively which is unsubstituted, monosubstituted by $-\text{CF}_3$ or at least monosubstituted by halogen, where, in addition, one or more CH_2 groups in these radicals may each, independently of one another, be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OCO}-$ or $-\text{OCO-O}-$ in such a way that heteroatoms are not directly adjacent, halogen, $-\text{CN}$, $-\text{SCN}$, $-\text{NCS}$, $-\text{SF}_5$, $-\text{CF}_3$, $-\text{OCF}_3$, $-\text{OCHF}_2$ or $-\text{OCH}_2\text{F}$,

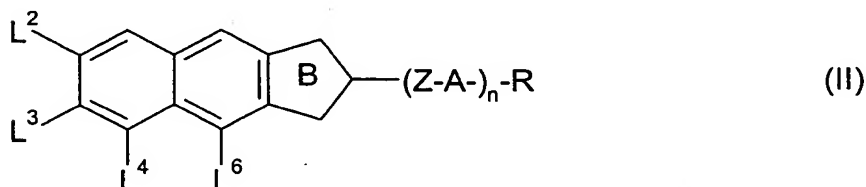
n is 0, 1, 2 or 3, and

$\text{L}^1 - \text{L}^8$ are each, independently of one another, hydrogen, an alkyl, alkoxy, alkenyl or alkynyl radical having from 1 to 15 or 2 to 15 carbon atoms respectively which is unsubstituted or at least monosubstituted by halogen, where, in addition, one or more CH_2 groups in these radicals may each, independently of one another, be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OCO}-$ or $-\text{OCO-O}-$ in such a way that heteroatoms are not directly adjacent, halogen, $-\text{CN}$, $-\text{SCN}$, $-\text{NCS}$, $-\text{SF}_5$, $-\text{CF}_3$, $-\text{OCF}_3$, $-\text{OCHF}_2$, $-\text{OCH}_2\text{F}$ or $-(\text{Z-A})_n\text{-R}$.

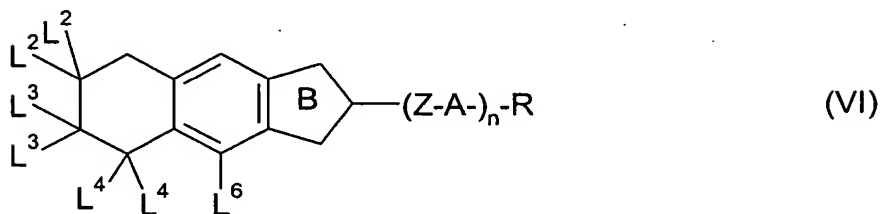
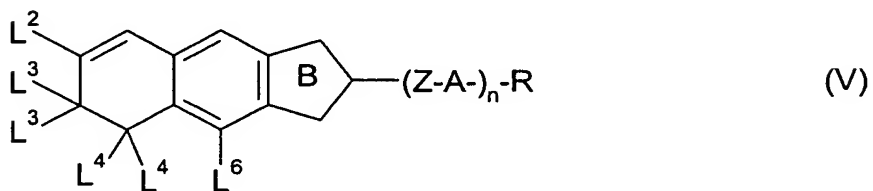
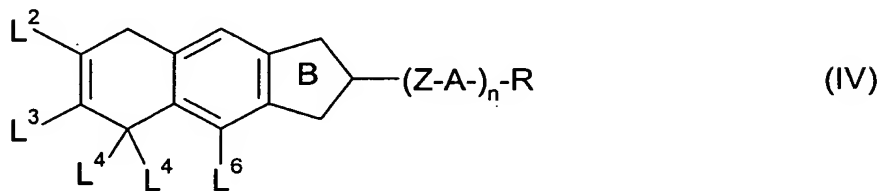
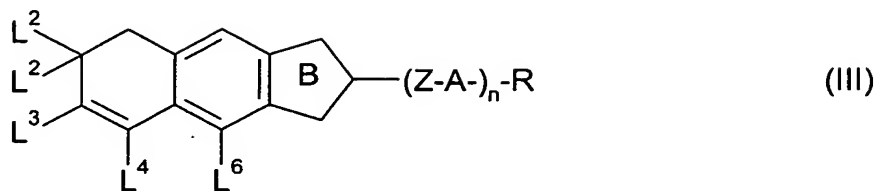
A further object of the present invention was to provide liquid-crystalline compounds, in particular for use in VA-TFT displays.

This object is achieved in accordance with the invention by the provision of cyclopenta[b]naphthalene derivatives of negative $\Delta\epsilon$.

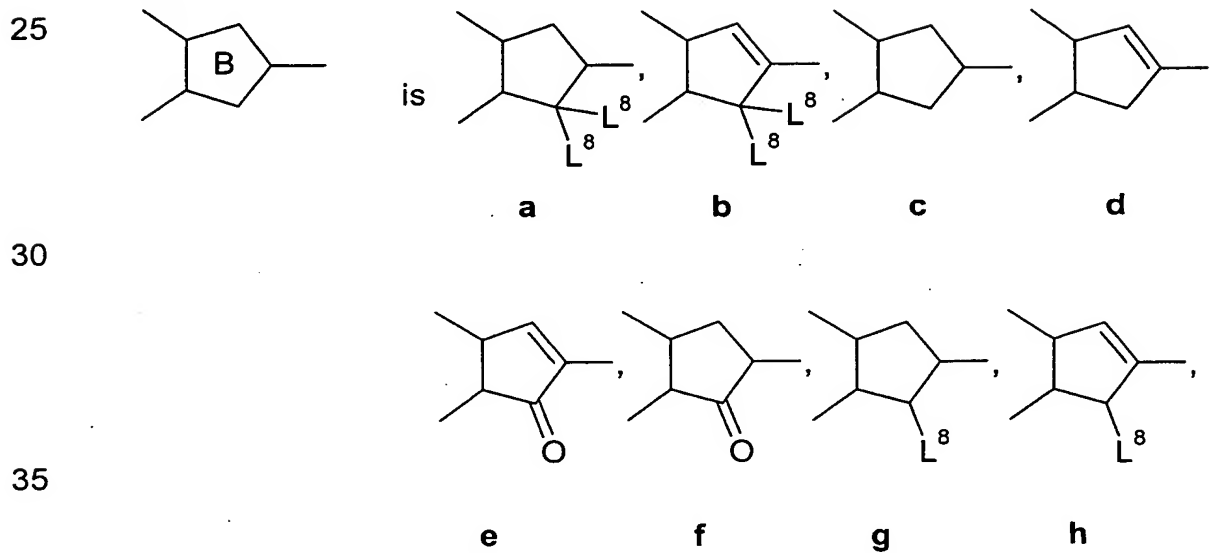
The present invention thus relates, in particular, to cyclopenta[b]naphthalene derivatives of the general formulae (II) to (VI)



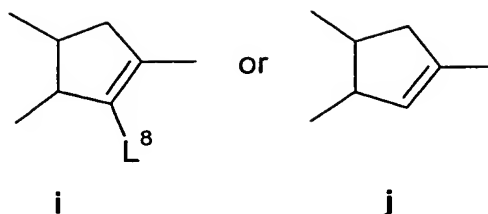
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in which:



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Z is in each case, independently of one another, a single bond, a double bond, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CF₂CF₂-, -C(O)O-, -OC(O)-, -CH₂O-, -OCH₂-, -CF=CH-, -CH=CF-, -CF=CF-, -CH=CH- or -C≡C-,

A is in each case, independently of one another, 1,4-phenylene, in which =CH- may be replaced once or twice by =N-, and which may be monosubstituted to tetrasubstituted, independently of one another, by halogen (-F, -Cl, -Br, -I), -CN, -CH₃, -CH₂F, -CHF₂, -CF₃, -OCH₃, -OCH₂F, -OCHF₂ or -OCF₃, 1,4-cyclohexylene, 1,4-cyclohexenylene or 1,4-cyclohexadienylene, in which -CH₂- may be replaced once or twice, independently of one another, by -O- or -S- in such a way that heteroatoms are not directly adjacent, and which may be monosubstituted or polysubstituted by halogen, or is 1,3-cyclobutylene or bicyclo[2.2.2]octane,

R is hydrogen, an alkyl, alkoxy, alkenyl or alkynyl radical having from 1 to 15 or 2 to 15 carbon atoms respectively which is unsubstituted, monosubstituted by -CF₃ or at least monosubstituted by halogen, where, in addition, one or more CH₂ groups in these radicals may each, independently of one another, be replaced by -O-, -S-, -CO-, -COO-, -OCO- or -OCO-O- in such a way that heteroatoms are not directly adjacent, halogen, -CN, -SCN, -NCS, -SF₅, -CF₃, -OCF₃, -OCHF₂ or -OCH₂F,

L², L³ and L⁸ are each, independently of one another, hydrogen, an alkyl, alkoxy, alkenyl or alkynyl radical having from 1 to 15 or 2 to 15 carbon atoms respectively which is unsubstituted or at least monosubstituted by halogen, where, in addition, one or more CH₂ groups in these radicals may each, independently of one another,

- 9 -

be replaced by -O-, -S-, -CO-, -COO-, -OCO- or -OCO-O- in such a way that heteroatoms are not directly adjacent, halogen, -CN, -SCN, -NCS, -SF₅, -CF₃, -OCF₃, -OCHF₂, -OCH₂F or -(Z-A)_n-R,

5 L⁴ and L⁶ are each, independently of one another, hydrogen, an alkyl, alkoxy, alkenyl or alkynyl radical having from 1 to 15 or 2 to 15 carbon atoms respectively which is at least monosubstituted by halogen, where, in addition, one or more CH₂ groups in these radicals may each, independently of one another, be replaced by -O-,
10 -S-, -CO-, -COO-, -OCO- or -OCO-O- in such a way that heteroatoms are not directly adjacent, halogen, -CN, -SF₅, -SCN, -NCS, -CF₃, -OCF₃, -OCHF₂ or -OCH₂F, preferably with the proviso that L⁴ and L⁶ cannot simultaneously be hydrogen, and

15 n is 0, 1, 2 or 3.

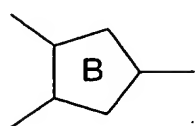
Preference is given to cyclopenta[b]naphthalene derivatives of the general formulae (II), (III), (V) and (VI), and particular preference is given to cyclopenta[b]naphthalene derivatives of the general formulae (II) and (VI).

20 The compounds all have negative $\Delta\epsilon$ and are therefore suitable, in particular, for use in VA-TFT displays. The compounds according to the invention preferably have a $\Delta\epsilon$ of < -2 and particularly preferably a $\Delta\epsilon$ of < -5 . They exhibit very good compatibility with the conventional substances used in liquid-crystal mixtures for displays.

25 The substituents, preferably fluorine substituents, in the naphthalene structure and the electronegative atoms in ring B generate a dipole moment perpendicular to the longitudinal axis of the molecules, which can, if desired, be further strengthened by suitable substituents in the wing units
30 -(Z-A)_n-R. In the field-free state, the compounds of the formulae (II) to (VI) orient themselves with their longitudinal axis of the molecules perpendicular to the treated or coated glass surface of the display.

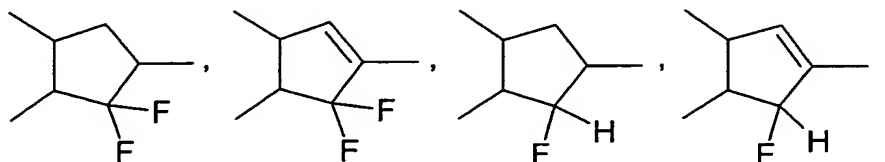
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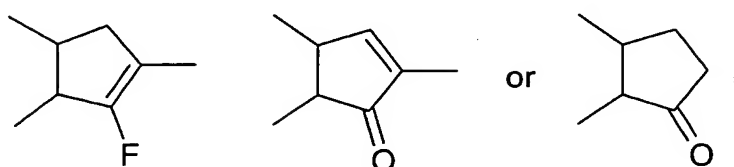


in the general formulae (II) to (VI) are preferably

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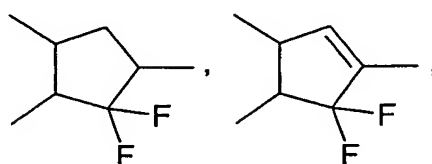


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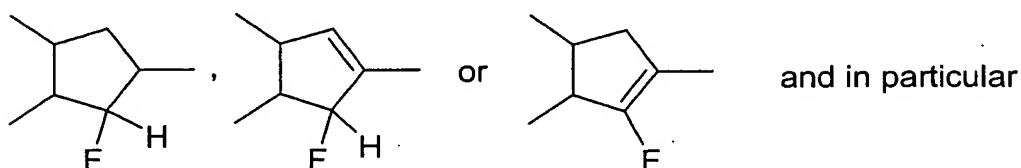


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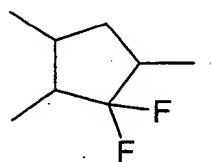
particularly preferably



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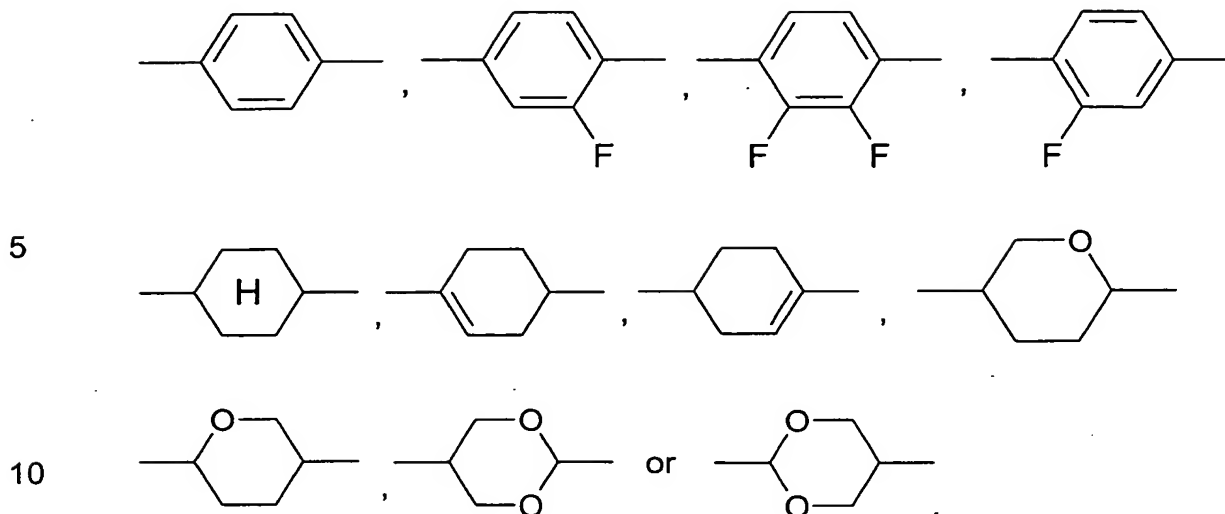
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In the general formulae (II) to (VI), A are preferably, independently of one another, optionally substituted 1,4-phenylene, optionally substituted 1,4-cyclohexylene, in which -CH₂- may be replaced once or twice by -O-, or optionally substituted 1,4-cyclohexenylene.

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A are particularly preferably, independently of one another,

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15 Preferred groups Z in the compounds of the general formulae (II) to (VI) are each, independently of one another, a single bond, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CF}_2\text{CF}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CH}-$, $-\text{CH}=\text{CF}-$ or $-\text{CF}=\text{CF}-$, particularly preferably a single bond, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CF}_2\text{CF}_2-$, $-\text{CF}=\text{CH}-$, $-\text{CH}=\text{CF}-$ or $-\text{CF}=\text{CF}-$.

20 R, L^2 and L^3 in the general formulae (II) to (VI) may each, independently of one another, be an alkyl radical and/or an alkoxy radical having from 1 to 15 carbon atoms, which may be straight-chain or branched. It is preferably straight-chain, has 1, 2, 3, 4, 5, 6 or 7 carbon atoms and accordingly is preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, methoxy, ethoxy, propoxy, butoxy, pentoxy, hexyloxy or heptyloxy.

25 R, L^2 and L^3 may each, independently of one another, be oxaalkyl, preferably straight-chain 2-oxapropyl (= methoxymethyl), 2- (= ethoxymethyl) or 3-oxabutyl (= methoxyethyl), 2-, 3- or 4-oxapentyl, 2-, 3-, 4- or 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl.

30 R, L^2 and L^3 may each, independently of one another, be an alkenyl radical having from 2 to 15 carbon atoms, which may be straight-chain or branched. It is preferably straight-chain and has from 2 to 7 carbon atoms. Accordingly, it is preferably vinyl, prop-1- or prop-2-enyl, but-1-, 2- or but-3-enyl, pent-1-, 2-, 3- or pent-4-enyl, hex-1-, 2-, 3-, 4- or hex-5-enyl, hept-1-, 2-, 3-, 4-, 5- or hept-6-enyl.

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5 R, L² and L³ may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms in which one CH₂ group has been replaced by -O- and one has been replaced by -CO-, where these are preferably adjacent. This thus contains an acyloxy group -CO-O- or an oxycarbonyl group -O-CO-. This is preferably straight-chain and has from 2 to 6 carbon atoms.

10 R, L² and L³ may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms in which one CH₂ group has been replaced by unsubstituted or substituted -CH=CH- and an adjacent CH₂ group has been replaced by CO or CO-O or O-CO, where this may be straight-chain or branched. It is preferably straight-chain and has from 4 to 13 carbon atoms.

15 R, L² and L³ may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms or alkenyl radical having from 2 to 15 carbon atoms, each of which is monosubstituted by -CN or -CF₃, where these are preferably straight-chain. The substitution by -CN or -CF₃ is possible in any desired position.

20 R, L² and L³ may each, independently of one another, be an alkyl radical in which two or more CH₂ groups have been replaced by -O- and/or -CO-O-, where this may be straight-chain or branched. It is preferably branched and has from 3 to 12 carbon atoms.

25 R, L², L³, L⁴ and L⁶ may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms or alkenyl radical having from 2 to 15 carbon atoms, each of which is at least monosubstituted by halogen, where these radicals are preferably straight-chain and halogen is preferably -F or -Cl. In the case of polysubstitution, halogen is preferably -F. The resultant radicals also include perfluorinated radicals, such as -CF₃. In the case of monosubstitution, the fluorine or chlorine substituent can be in any desired position, but is preferably in the ω-position.

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R in the general formulae (II) to (VI) is particularly preferably an alkyl radical, alkoxy radical or alkenyl radical having from 1 to 7 or 2 to 7 carbon atoms respectively.

5 L² and L³ in the general formulae (II) to (VI) is preferably hydrogen, an alkyl radical, alkoxy radical or alkenyl radical having from 1 to 7 or 2 to 7 carbon atoms respectively or a halogen, particularly preferably hydrogen, an alkoxy radical having from 1 to 7 carbon atoms, fluorine or chlorine, and in particular fluorine.

10 L⁴ and L⁶ in the general formulae (II) to (VI) is preferably hydrogen, an alkyl radical, alkoxy radical or alkenyl radical having from 1 to 7 or 2 to 7 carbon atoms respectively, each of which is at least monosubstituted by halogen, or a halogen, particularly preferably -CF₃, fluorine or chlorine, and in particular fluorine.

15 L⁸ in the general formulae (II) to (VI) is preferably fluorine.

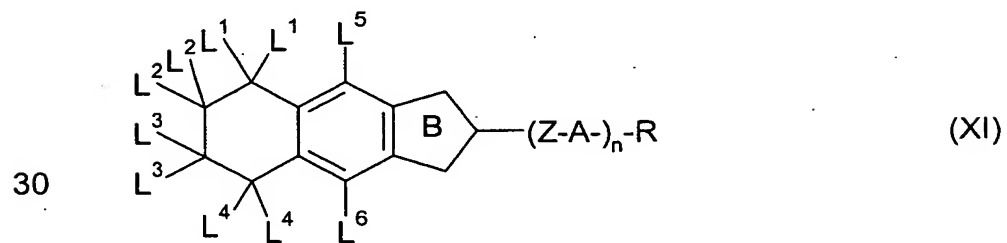
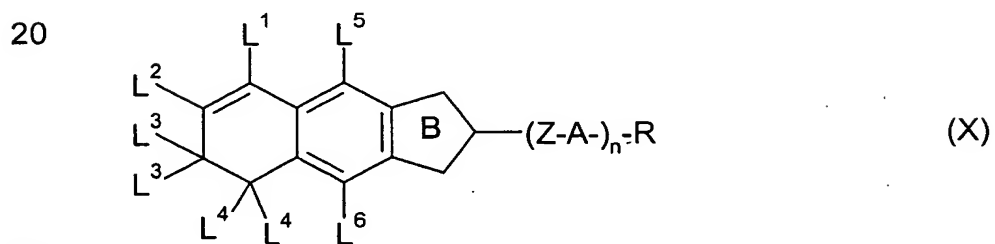
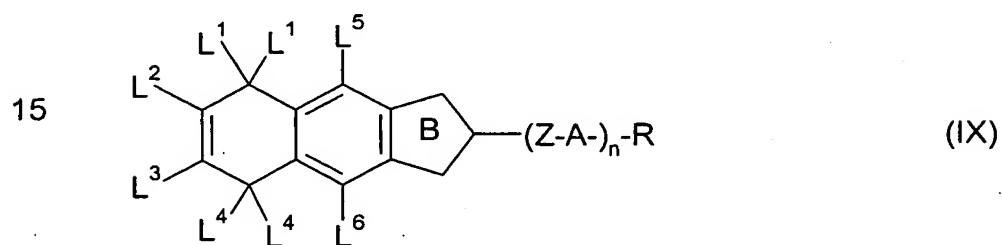
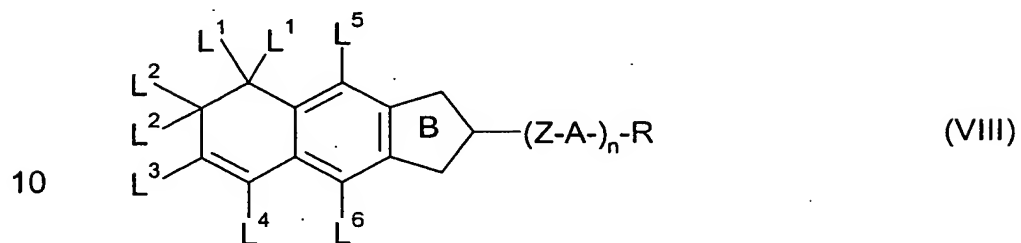
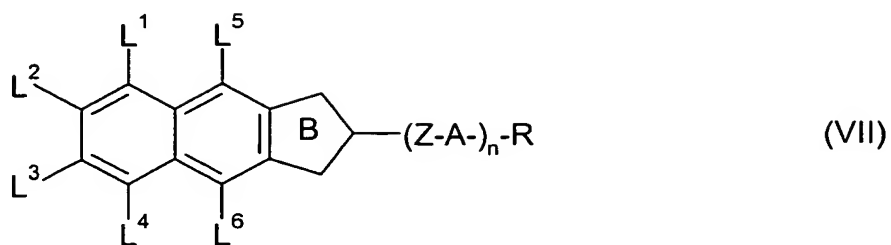
20 Preferred compounds of the general formulae (II) to (VI) have no, one or two wing units ZA, i.e. n = 0, 1 or 2, particularly preferably n = 1.

25 A further object of the present invention was to provide compounds, in particular for use in mesogenic control media, where these control media are employed, in particular, in electro-optical light-control elements which are operated at a temperature at which the mesogenic control medium in the unaddressed state is in the isotropic phase.

This object is achieved in accordance with the invention by the provision of cyclopenta[b]naphthalene derivatives of positive $\Delta\epsilon$.

30 The present invention thus relates, in particular, to cyclopenta[b]naphthalene derivatives of the general formulae (VII) to (XI)

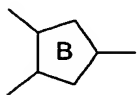
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in which Z, A, R, n, L¹ to L⁸ and

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have the meanings indicated in relation to the formula (I).

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Preference is given to cyclopenta[b]naphthalene derivatives of the general formulae (VII) and (XI), and particular preference is given to cyclopenta[b]-naphthalene derivatives of the general formula (VII).

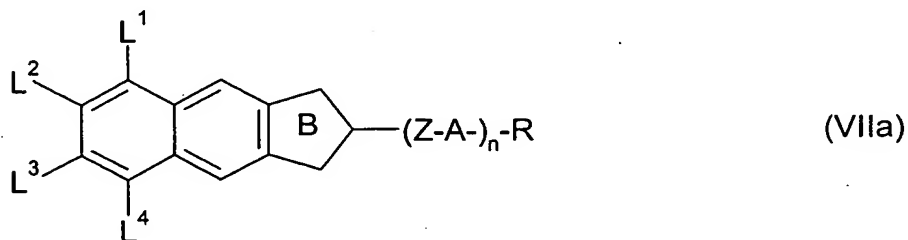
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The compounds of the formulae (VII) to (XI) all have positive $\Delta\epsilon$. The compounds of the formulae (VII) to (XI) according to the invention preferably have a $\Delta\epsilon$ of $> +10$, particularly preferably a $\Delta\epsilon$ of $> +15$ and in particular a $\Delta\epsilon$ of $> +20$. They exhibit very good compatibility with the conventional substances used in mesogenic control media.

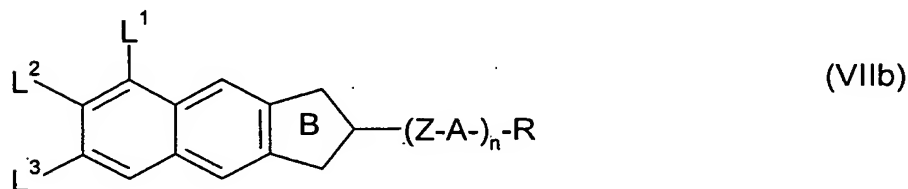
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The cyclopenta[b]naphthalene derivatives of the general formula (VII) preferably have the following structural formulae:

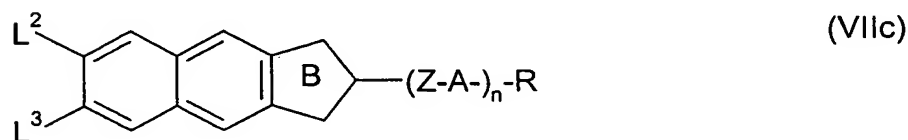
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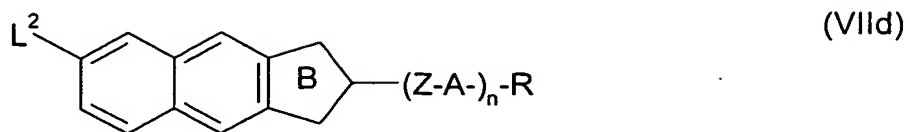


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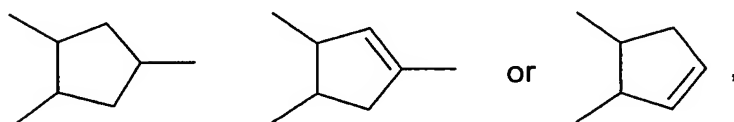
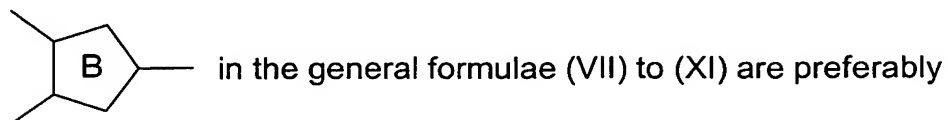


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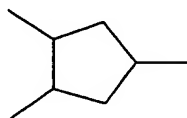
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where the structural formulae (VIIa) and (VIIc) are particularly preferred.

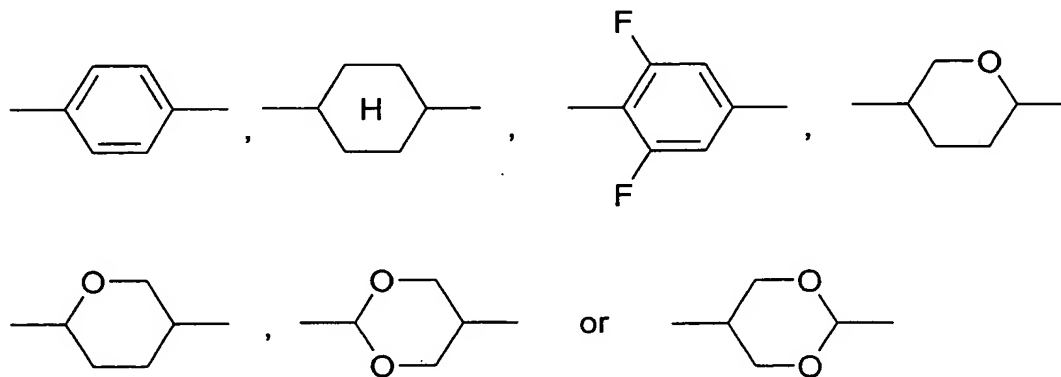


particularly preferably



In the general formulae (VII) to (XI), A are preferably, independently of one another, optionally substituted 1,4-phenylene, optionally substituted 1,4-cyclohexylene, in which -CH₂- may be replaced once or twice by -O-, or optionally substituted 1,4-cyclohexenylenes.

A are particularly preferably, independently of one another,



Preferred groups Z in the compounds of the general formulae (VII) to (XI) are each, independently of one another, a single bond, -CF₂O-, -OCF₂-, -CF₂CF₂-, -CH=CH-, -CF=CH-, -CH=CF- or -CF=CF-, particularly preferably a single bond, -CF₂O-, -OCF₂-, -CF₂CF₂- or -CF=CF-.

5 R and L¹ to L⁸ in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical and/or an alkoxy radical having from 1 to 15 carbon atoms, which may be straight-chain or branched. It is preferably straight-chain, has 1, 2, 3, 4, 5, 6 or 7 carbon atoms and accordingly is preferably methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl,
10 methoxy, ethoxy, propoxy, butoxy, pentoxy, hexoxy or heptoxy.

R and L¹ to L⁸ in the general formulae (VII) to (XI) may each, independently of one another, be oxaalkyl, preferably straight-chain 2-oxapropyl (= methoxymethyl), 2- (= ethoxymethyl) or 3-oxabutyl (= methoxyethyl), 2-,
15 3- or 4-oxapentyl, 2-, 3-, 4- or 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl.

R and L¹ to L⁸ in the general formulae (VII) to (XI) may each, independently of one another, be an alkenyl radical having from 2 to 15 carbon atoms, which may be straight-chain or branched. It is preferably straight-chain and has from 2 to 7 carbon atoms. Accordingly, it is preferably vinyl,
20 prop-1- or prop-2-enyl, but-1-, 2- or but-3-enyl, pent-1-, 2-, 3- or pent-4-enyl, hex-1-, 2-, 3-, 4- or hex-5-enyl, hept-1-, 2-, 3-, 4-, 5- or hept-6-enyl.

R and L¹ to L⁸ in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms in which one CH₂ group has been replaced by -O- and one has been replaced by -CO-, where these are preferably adjacent. This thus contains an acyloxy group -CO-O- or an oxycarbonyl group -O-CO-. This is preferably straight-chain and has from 2 to 6 carbon atoms.
25

R and L¹ to L⁸ in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms in which one CH₂ group has been replaced by unsubstituted or substituted -CH=CH- and an adjacent CH₂ group has been replaced by CO or CO-O or O-CO, where this may be straight-chain or branched. It is preferably straight-chain and has from 4 to 13 carbon atoms.
30
35

R and L^1 to L^8 in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms or alkenyl radical having from 2 to 15 carbon atoms, each of which is monosubstituted by -CN or -CF₃, where these are preferably straight-chain.
5 The substitution by -CN or -CF₃ is possible in any desired position.

R and L^1 to L^8 in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical in which two or more CH₂ groups have been replaced by -O- and/or -CO-O-, where this may be straight-chain or branched. It is preferably branched and has from 3 to 12 carbon atoms.
10

R and L^1 to L^8 in the general formulae (VII) to (XI) may each, independently of one another, be an alkyl radical having from 1 to 15 carbon atoms or alkenyl radical having from 2 to 15 carbon atoms, each of which is at least monosubstituted by halogen, where these radicals are preferably straight-chain and halogen is preferably -F or -Cl. In the case of polysubstitution, halogen is preferably -F. The resultant radicals also include perfluorinated radicals, such as -CF₃. In the case of monosubstitution, the fluorine or chlorine substituent can be in any desired position, but is preferably in the ω -position.
15
20

R in the general formulae (VII) to (XI) is particularly preferably an alkyl radical, alkoxy radical or alkenyl radical having from 1 to 7 or 2 to 7 carbon atoms respectively, in particular an alkyl radical having from 1 to 7 carbon atoms.
25

L^2 and L^3 in the general formulae (VII) to (XI) is preferably, independently of one another, identical or different and is hydrogen, halogen, -CN, -SCN, -NCS, -SF₅, -CF₃, -CHF₂, -OCF₃ or -OCHF₂, particularly preferably hydrogen, fluorine, -CF₃ or -OCF₃. In particular, however, L^2 and/or L^3 is not hydrogen.
30

L^1 and L^4 in the general formulae (VII) to (XI) is preferably, independently of one another, identical or different and is hydrogen or fluorine. Particularly preferably, however, $L^1 = L^4 = H$ or $L^1 = L^4 = F$.
35

L⁵ and L⁶ in the general formulae (VII) to (XI) is preferably hydrogen.

Particular preference is given to compounds of the general formulae (VII) to (XI) in which L₁ = L₂ = L₃ = L₄ = F and L₅ = L₆ = H.

5

Preferred compounds of the general formulae (VII) to (XI) have no, one or two wing units ZA, i.e. n = 0, 1 or 2, particularly preferably n = 1.

10

The compounds of the general formulae (I), (II) to (VI) and (VII) to (XI) are prepared by methods known per se, as described in the literature (for example in the standard works, such as Houben-Weyl, Methoden der organischen Chemie [Methods of Organic Chemistry], Georg-Thieme-Verlag, Stuttgart), to be precise under reaction conditions which are known and are suitable for the said reactions. Use can be made here of variants known per se, which are not mentioned here in greater detail.

15

If desired, the starting materials can also be formed in situ by not isolating them from the reaction mixture, but instead immediately converting them further into the compounds of the general formulae (I) to (XI).

20

The syntheses of various polysubstituted naphthalene derivatives which are used to build up the five-membered ring are described by way of example in the examples. The starting substances are obtainable by generally accessible literature procedures or commercially. The reactions described should likewise be regarded as known from the literature.

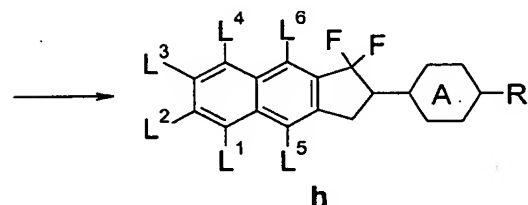
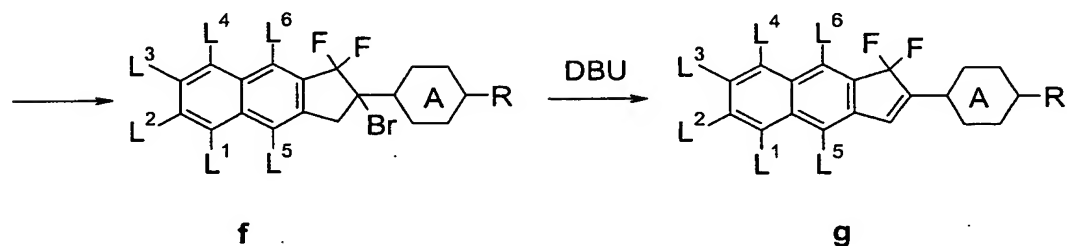
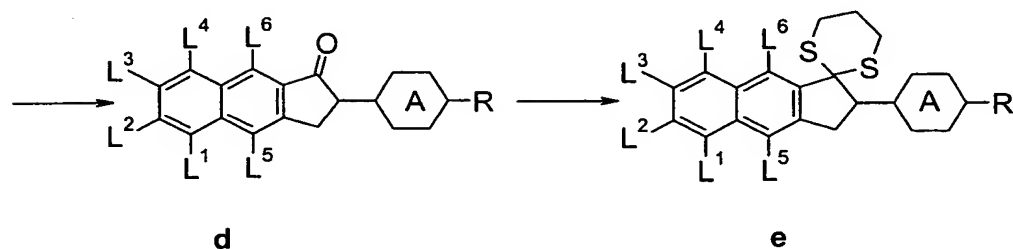
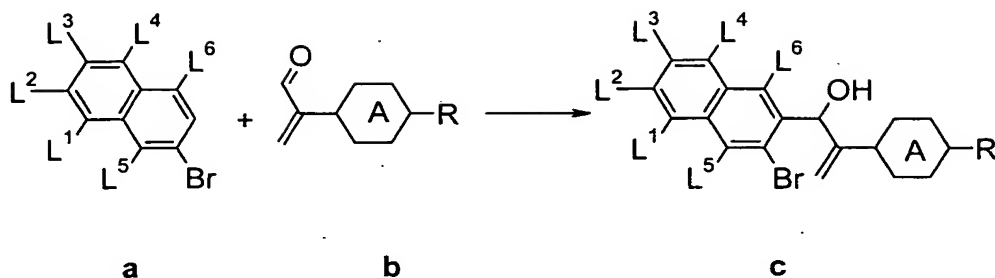
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An illustrative synthesis for building up the five-membered ring is shown below. The synthesis can be adapted to the particular desired compounds of the general formulae (I) to (XI) through the choice of suitable starting materials.

30

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- 20 -



25 Starting from the 3-bromonaphthalene **a**, reaction with an α,β -unsaturated aldehyde **b** in the presence of lithium diisopropylamide (LDA) gives compound **c**. This reacts with palladium catalysis in the presence of triethylamine with ring closure to give the ketone **d**. From the ketone **d** and 1,3-propanedithiol in the presence of BF_3 /diethyl ether, the corresponding dithiane **e** is obtained. This is reacted with 1,3-dibromo-5,5-dimethylhydantoin (DBH) and HF in pyridine to give the cyclopenta[b]naphthalene derivative **f**. Elimination of HBr in the presence of diazabicycloundecene (DBU) gives the cyclopenta[b]naphthalene derivative **g**. The cyclopenta[b]naphthalene derivative **g** is hydrogenated on the palladium/carbon catalyst in a hydrogen atmosphere to give the cyclopenta[b]naphthalene derivative **h**.

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- 21 -

The reactions described should only be regarded as illustrative. The person skilled in the art can carry out corresponding variations of the syntheses described and also follow other suitable synthetic routes in order to obtain compounds of the formulae (I) to (XI).

5 As already mentioned, the compounds of the general formulae (I) to (XI) can be used in liquid-crystalline media.

The present invention therefore also relates to a liquid-crystalline medium comprising at least two liquid-crystalline compounds, comprising at least
10 one compound of the general formulae (I) to (XI).

The present invention also relates to liquid-crystalline media comprising from 2 to 40, preferably from 4 to 30, components as further constituents besides one or more compounds of the formulae (I), (II), (III), (IV), (V), (VI), (VII),
15 (VIII), (IX), (X) and/or (XI) according to the invention. These media particularly preferably comprise from 7 to 25 components besides one or more compounds according to the invention. These further constituents are preferably selected from nematic or nematogenic (monotropic or isotropic) substances, in particular substances from the classes of the azoxy-
20 benzenes, benzylideneanilines, biphenyls, terphenyls, phenyl or cyclohexyl benzoates, phenyl or cyclohexyl esters of cyclohexanecarboxylic acid, phenyl or cyclohexyl esters of cyclohexylbenzoic acid, phenyl or cyclohexyl esters of cyclohexylcyclohexanecarboxylic acid, cyclohexylphenyl esters of benzoic acid, of cyclohexanecarboxylic acid or of cyclohexylcyclohexanecar-
25 boxylic acid, phenylcyclohexanes, cyclohexylbiphenyls, phenylcyclohexylcyclohexanes, cyclohexylcyclohexanes, cyclohexylcyclohexylcyclohexenes, 1,4-biscyclohexylbenzenes, 4',4'-biscyclohexylbiphenyls, phenyl- or cyclohexylpyrimidines, phenyl- or cyclohexylpyridines, phenyl- or cyclohexyl-
30 dioxanes, phenyl- or cyclohexyl-1,3-dithianes, 1,2-diphenylethanes, 1,2-dicyclohexylethanes, 1-phenyl-2-cyclohexylethanes, 1-cyclohexyl-2-(4-phenylcyclohexyl)ethanes, 1-cyclohexyl-2-biphenylethanes, 1-phenyl-2-cyclohexylphenylethanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolans and substituted cinnamic acids. The 1,4-phenylene groups in these
35 compounds may also be fluorinated.

The most important compounds suitable as further constituents of media according to the invention can be characterised by the formulae (1), (2), (3), (4) and (5):

	R'-L-E-R''	(1)
5	R'-L-COO-E-R''	(2)
	R'-L-OOC-E-R''	(3)
	R'-L-CH ₂ CH ₂ -E-R''	(4)
	R'-L-CF ₂ O-E-R''	(5)

10 In the formulae (1), (2), (3), (4) and (5), L and E, which may be identical or different, are each, independently of one another, a divalent radical from the group formed by -Phe-, -Cyc-, -Phe-Phe-, -Phe-Cyc-, -Cyc-Cyc-, -Pyr-, -Dio-,
 15 -G-Phe- and -G-Cyc- and their mirror images, where Phe is unsubstituted or fluorine-substituted 1,4-phenylene, Cyc is trans-1,4-cyclohexylene or 1,4-cyclohexylene, Pyr is pyrimidine-2,5-diyl or pyridine-2,5-diyl, Dio is 1,3-dioxane-2,5-diyl, and G is 2-(trans-1,4-cyclohexyl)ethyl.

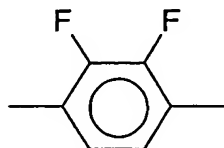
One of the radicals L and E is preferably Cyc or Phe. E is preferably Cyc, Phe or Phe-Cyc. The media according to the invention preferably comprise
 20 one or more components selected from the compounds of the formulae (1), (2), (3), (4) and (5) in which L and E are selected from the group consisting of Cyc and Phe and simultaneously one or more components selected from the compounds of the formulae (1), (2), (3), (4) and (5) in which one of the radicals L and E is selected from the group consisting of Cyc and Phe and
 25 the other radical is selected from the group consisting of -Phe-Phe-, -Phe-Cyc-, -Cyc-Cyc-, -G-Phe- and -G-Cyc-, and optionally one or more components selected from the compounds of the formulae (1), (2), (3), (4) and (5) in which the radicals L and E are selected from the group consisting of -Phe-Cyc-, -Cyc-Cyc-, -G-Phe- and -G-Cyc-.

30 In a smaller sub-group of the compounds of the formulae (1), (2), (3), (4) and (5), R' and R'' are each, independently of one another, alkyl, alkenyl, alkoxy, alkoxyalkyl, alkenyloxy or alkanoyloxy having up to 8 carbon atoms. This smaller sub-group is called group A below, and the compounds are
 35 referred to by the sub-formulae (1a), (2a), (3a), (4a) and (5a). In most of

- 23 -

these compounds, R' and R'' are different from one another, one of these radicals usually being alkyl, alkenyl, alkoxy or alkoxyalkyl.

In another smaller sub-group of the compounds of the formulae (1), (2), (3), (4) and (5), which is referred to as group B, E is



In the compounds of group B, which are referred to by the sub-formulae (1b), (2b), (3b), (4b) and (5b), R' and R'' are as defined for the compounds of the sub-formulae (1a) to (5a) and are preferably alkyl, alkenyl, alkoxy or alkoxyalkyl.

In a further smaller sub-group of the compounds of the formulae (1), (2), (3), (4) and (5), R'' is -CN; this sub-group is referred to below as group C, and the compounds of this sub-group are correspondingly described by sub-formulae (1c), (2c), (3c), (4c) and (5c). In the compounds of the sub-formulae (1c), (2c), (3c), (4c) and (5c), R' is as defined for the compounds of the sub-formulae (1a) to (5a) and is preferably alkyl, alkenyl, alkoxy or alkoxyalkyl.

Besides the preferred compounds of groups A, B and C, other compounds of the formulae (1), (2), (3), (4) and (5) having other variants of the proposed substituents are also customary. All these substances are obtainable by methods which are known from the literature or analogously thereto.

Besides the compounds of the general formulae (I), (II), (III), (IV), (V), (VI), (VII), (VIII), (IX), (X) and/or (XI) according to the invention, the media according to the invention preferably comprise one or more compounds from groups A, B and/or C. The proportions by weight of the compounds from these groups in the media according to the invention are:

- 24 -

group A: from 0 to 90%, preferably from 20 to 90%, in particular from 30 to 90%

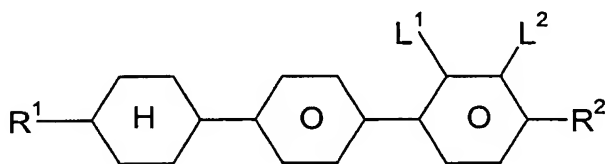
group B: from 0 to 80%, preferably from 10 to 80%, in particular from 10 to 70%

5 group C: from 0 to 80%, preferably from 5 to 80%, in particular from 5 to 50%.

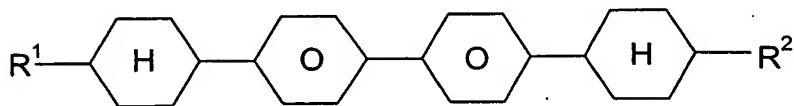
The media according to the invention preferably comprise from 1 to 40%, particularly preferably from 5 to 30%, of the compounds of the formulae (I), (II), (III), (IV), (V), (VI), (VII), (VIII), (IX), (X) and/or (XI) according to the
10 invention. Preference is furthermore given to media comprising more than 40%, in particular from 45 to 90%, of compounds of the formulae (I), (II), (III), (IV), (V), (VI), (VII), (VIII), (IX), (X) and/or (XI) according to the invention. The media preferably comprise three, four or five compounds of the
15 formulae (I), (II), (III), (IV), (V), (VI), (VII), (VIII), (IX), (X) and/or (XI) according to the invention.

Examples of the compounds of the formulae (1), (2), (3), (4) and (5) are the compounds listed below:

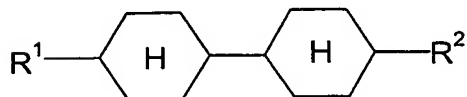
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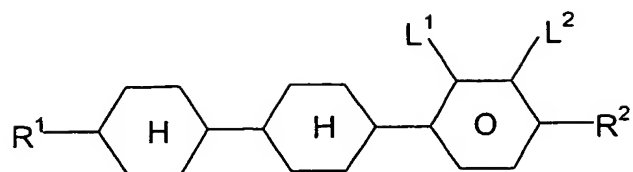


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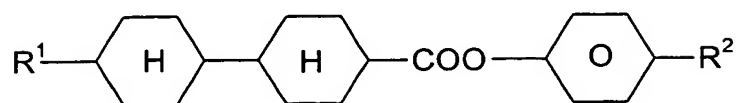


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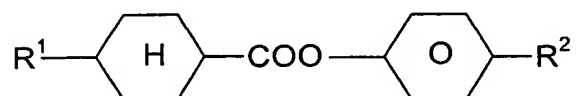
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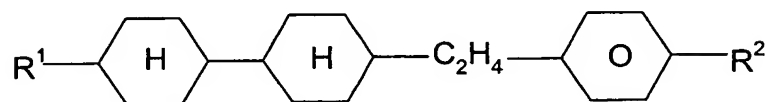
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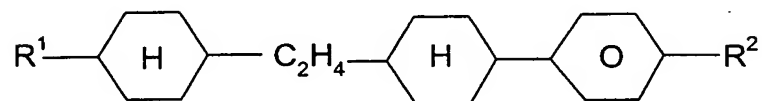
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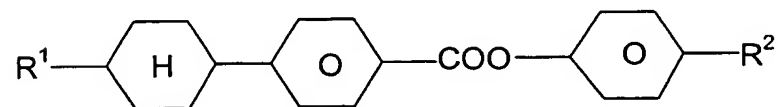
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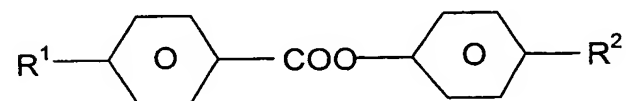
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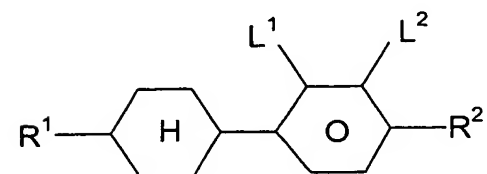
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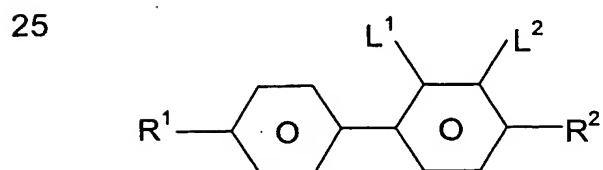
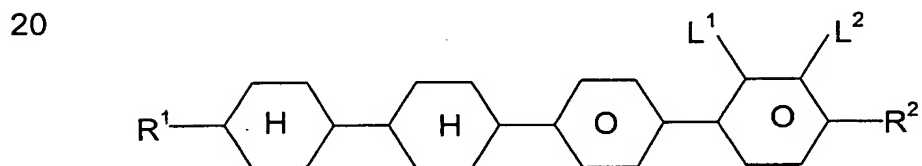
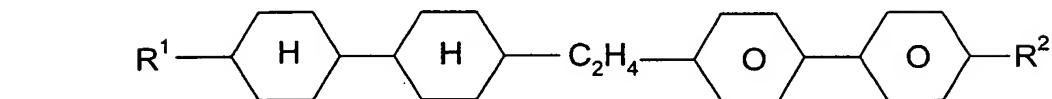
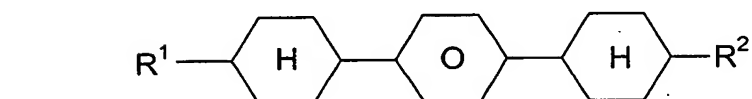
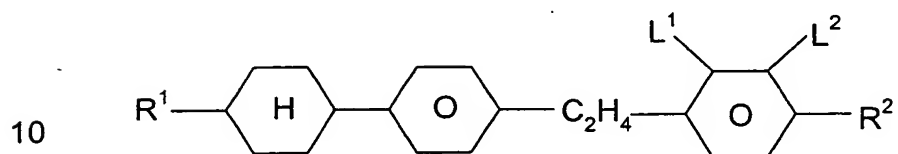
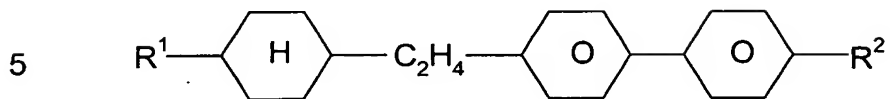
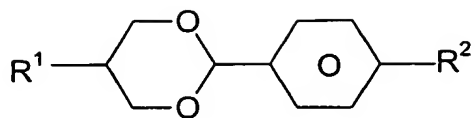
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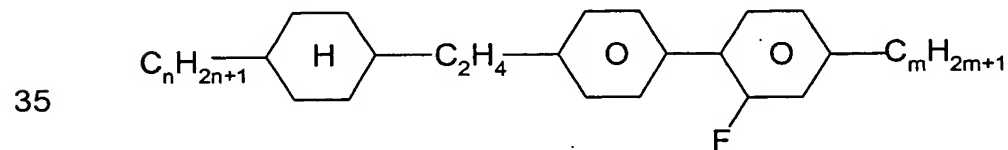


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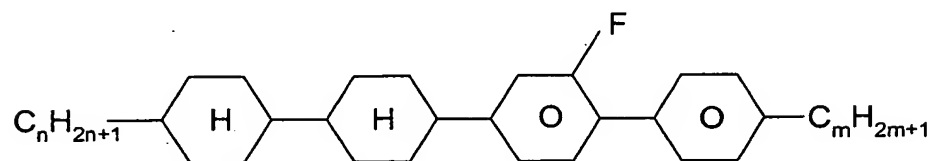
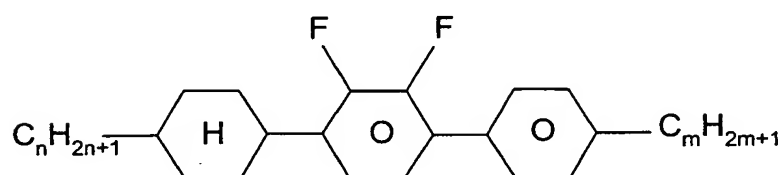
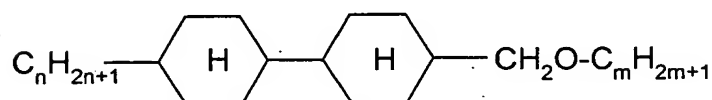
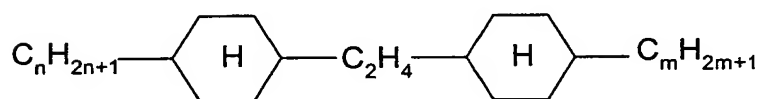
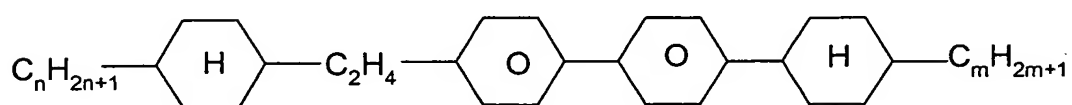
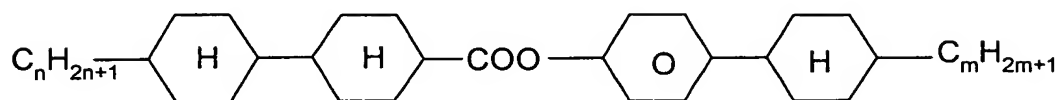
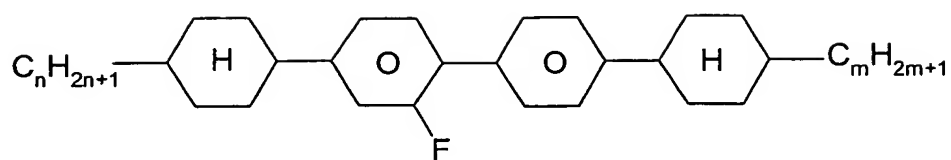


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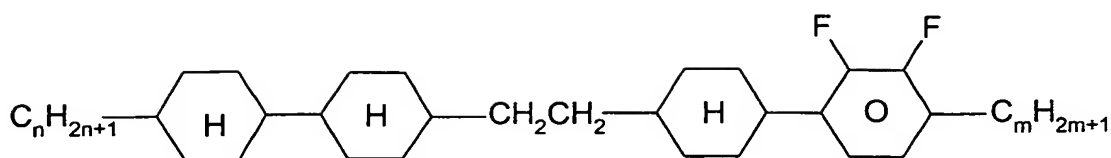
where R^1 , R^2 , independently of one another, $-C_nH_{2n+1}$ or $-OC_nH_{2n+1}$, and $n = 1$ to 8 , and L^1 , L^2 , independently of one another, $-H$ or $-F$,



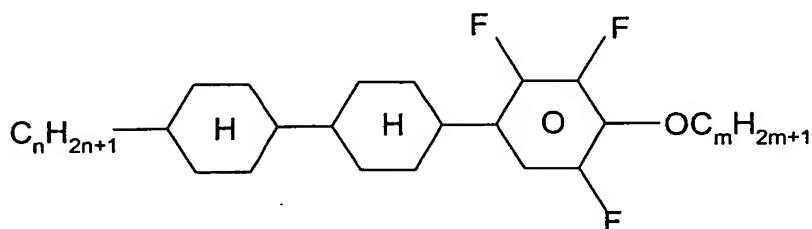
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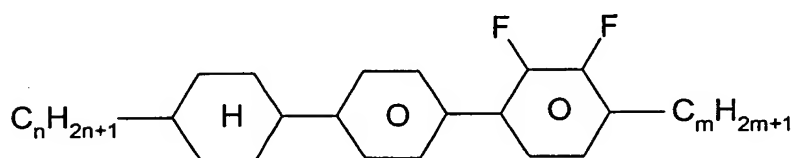
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where m , n , independently of one another, from 1 to 8.

The media according to the invention are prepared in a manner conventional per se. In general, the components are dissolved in one another, advantageously at elevated temperature. By means of suitable additives, the liquid-crystalline phases of the present invention can be modified in such a way that they can be used in all types of liquid-crystal display elements that have been disclosed hitherto. Additives of this type are known to the person skilled in the art and are described in detail in the literature (H. Kelker/R. Hatz, Handbook of Liquid Crystals, Verlag Chemie, Weinheim, 1980). For example, pleochroic dyes can be added for the preparation of coloured guest-host systems or substances can be added in order to modify the dielectric anisotropy, the viscosity and/or the orientation of the nematic phases.

30

Owing to their negative $\Delta\epsilon$, the compounds of the formulae (II) to (VI) are particularly suitable for use in VA-TFT displays.

The present invention therefore also relates to electro-optical liquid-crystal display elements containing a liquid-crystalline medium according to the invention.

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- 29 -

Owing to their high positive $\Delta\epsilon$, the compounds of the formulae (VII) to (XI) are particularly suitable for use in mesogenic control media, these control media being employed, in particular, in electro-optical light-control elements which are operated at a temperature at which the mesogenic control medium in the unaddressed state is in the isotropic phase.

The present invention therefore also relates to electro-optical light-control elements, as disclosed, for example, in DE 102 17 273 A1, which contain an electrode arrangement, at least one element for polarisation of the light and a mesogenic control medium, where the light-control element is operated at a temperature at which the mesogenic control medium in the unaddressed state is in the isotropic phase, and which are characterised in that the mesogenic control medium comprises one or more compounds of the formulae (VII) to (XI).

The invention is explained in greater detail below with reference to working examples, but without being restricted thereby.

Examples

The starting substances can be obtained by generally accessible literature procedures or commercially. The reactions described are known from the literature.

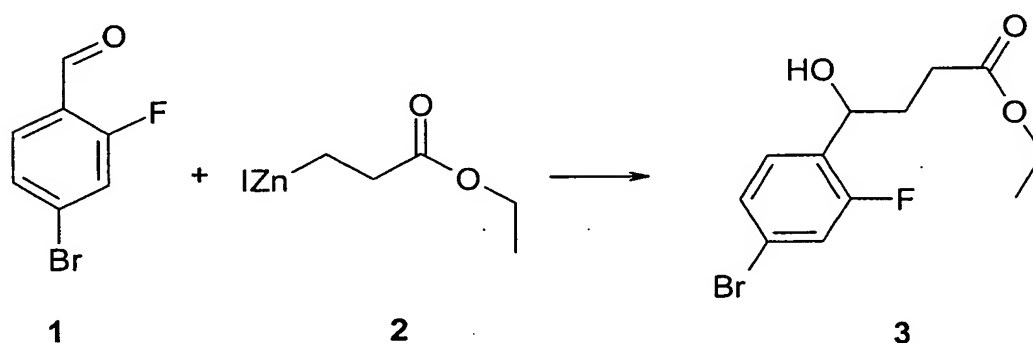
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A) Preparation of the naphthalene derivatives

Example 1

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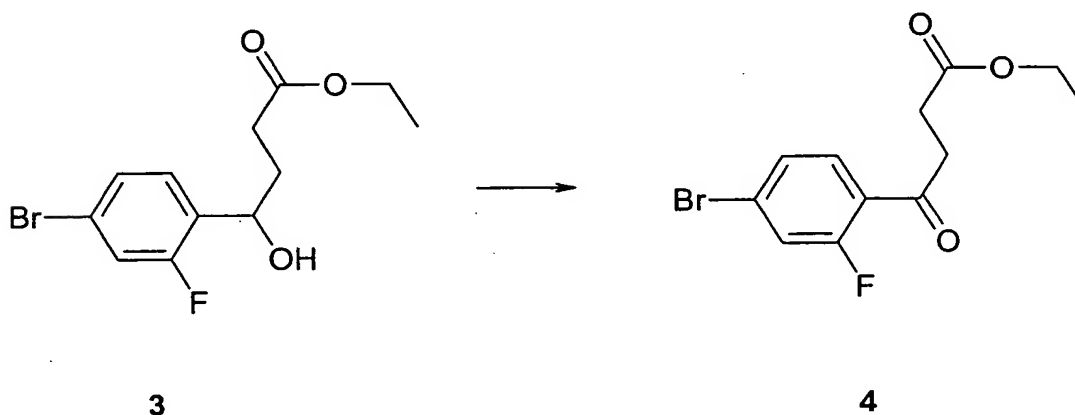


20

200 ml (100 mmol) of a 0.5 M solution of the zinc compound 2 in THF are added at -75°C to a solution of 20.0 g (98.5 mmol) of the aldehyde 1 in 100 ml of THF. After 30 minutes, the cooling is removed. Water is added to the thawed batch, which is acidified using 1 N HCl solution and extracted with tert-butyl methyl (MTB) ether. Drying, evaporation and chromatography on silica gel gives the hydroxy ester 3.

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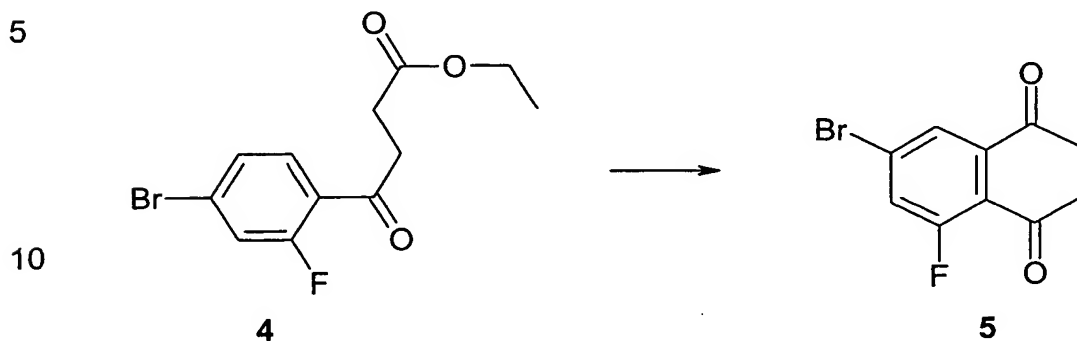


35

A solution of 10.0 g (32.7 mmol) of the hydroxy ester 3 is added at room temperature to a suspension of 40.0 mmol of pyridinium chlorochromate

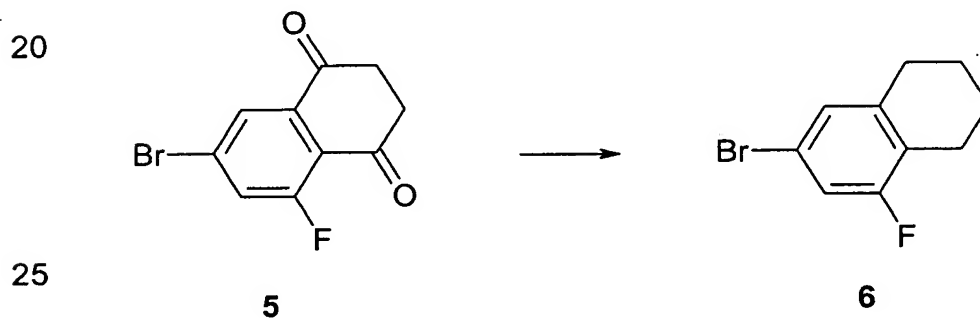
- 31 -

(PCC) on 50 g of Celite® in 150 ml of dichloromethane. When the reaction is complete (TLC), the batch is filtered, and the filter cake is washed with methylene chloride. Evaporation and chromatography on silica gel gives the keto ester 4.



15

9.0 g (29.7 mmol) of the keto ester 4 are added at 60°C to 100 g of polyphosphoric acid. The temperature is subsequently increased to 120°C for 4 hours. After cooling, the batch is added to ice and extracted with tert-butyl methyl (MTB) ether. Drying, evaporation and crystallisation gives the diketone 5.

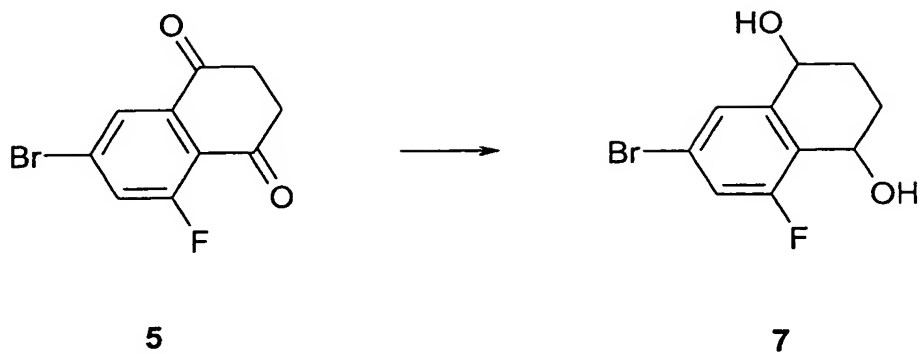


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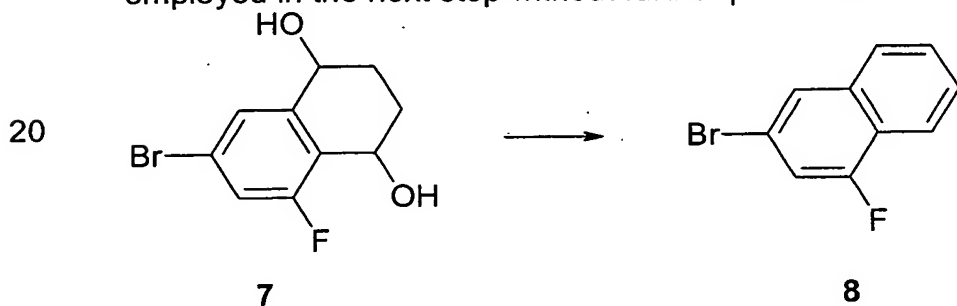
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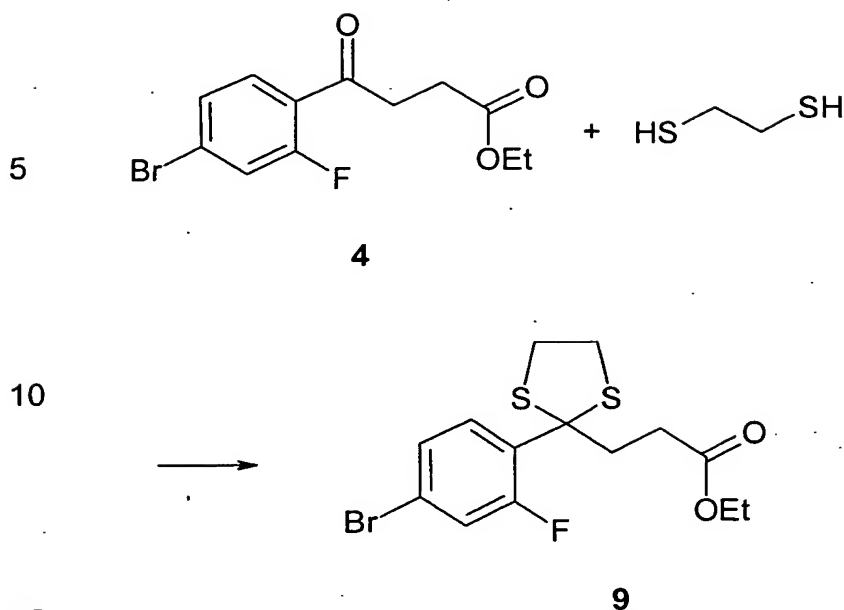
5.0 g (19.5 mmol) of the diketone 5 are dissolved in 5 ml of ethanol, 3 ml of 100% hydrazinium hydroxide and 0.5 ml of water are added, and the mixture is refluxed for 30 minutes. A solution of 800 mg of sodium in 15 ml of ethanol is subsequently added to the reaction vessel. The batch is heated at 140°C until the evolution of nitrogen is complete. 2/3 of the ethanol is subsequently distilled off. The residue is diluted with 50 ml of water and extracted with ether. The extract is washed with 10% KOH, 5% HCl and 30% sodium hydrogensulfite solution. Drying, evaporation and chromatography on silica gel gives the tetrahydronaphthalene 6.

Example 2

8.0 g (31.1 mmol) of the diketone **5** are dissolved in 150 ml of ethanol, and 2.4 g (65.0 mmol) of sodium borohydride are added in portions. When the reaction is complete (TLC), the batch is hydrolysed using water, the ethanol is removed under reduced pressure, and the residue is taken up in water and extracted with toluene. After evaporation, the product is employed in the next step without further purification.

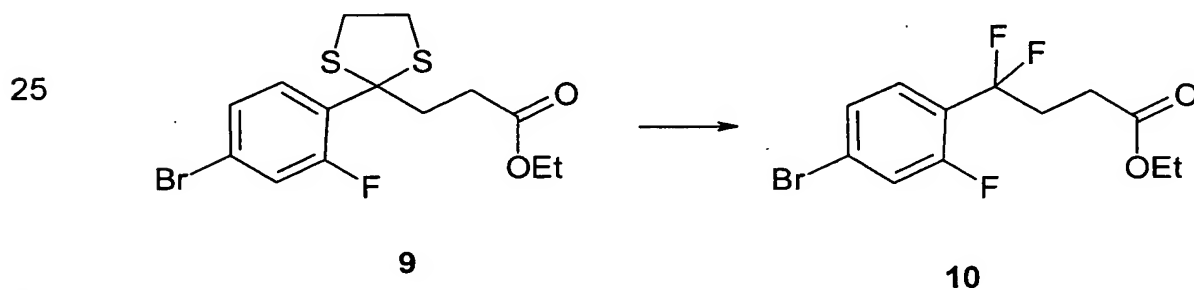


10.0 g (38.3 mmol) of the diol **7** are dissolved in 200 ml of toluene, 1 g of p-toluenesulfonic acid is added, and the mixture is refluxed until the separation of water is complete. Evaporation and filtration through silica gel gives the naphthalene derivative **8**.

Example 3

30 ml of boron trifluoride/diethyl ether complex are added under nitrogen to a solution of 15.0 g (49.5 mmol) of the keto ester 4 and 8.4 ml (100 mmol) of the dithiol in 150 ml of dichloromethane, and the mixture is stirred overnight. The batch is slowly added to saturated sodium hydrogen-carbonate solution and deacidified. Drying, evaporation and chromatography on silica gel gives the protected ketone 9.

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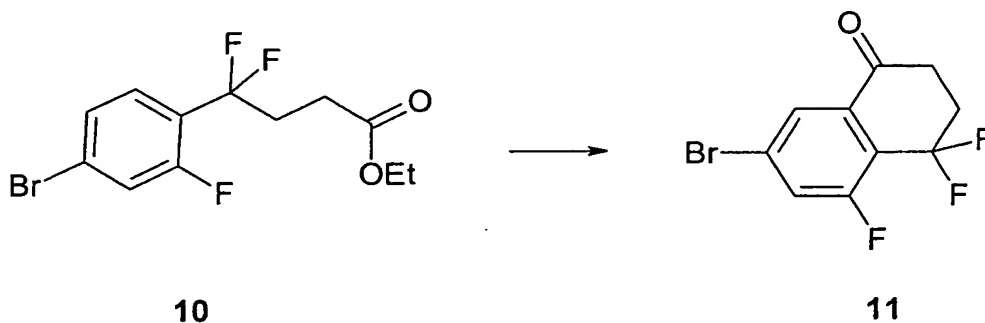
A solution of 10 g (26.4 mmol) of the protected ketone 9 in 60 ml of dichloromethane is added at -75°C to a suspension of 30.2 g (105.2 mmol) of 1,3-dibromo-5,5-dimethylhydantoin in 60 ml of dichloromethane and 120 ml of a 65% solution of hydrogen fluoride in pyridine. The batch is slowly warmed to 0°C over the course of 3 hours and added to 1500 ml of ice-cooled 2 N sodium hydroxide solution to which 120 ml of a 39%

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- 34 -

sodium hydrogensulfite solution have been added. The pH is adjusted to 8, and the aqueous phase is extracted with methylene chloride. Drying, evaporation and chromatography on silica gel gives the fluorinated ester **10**.

5

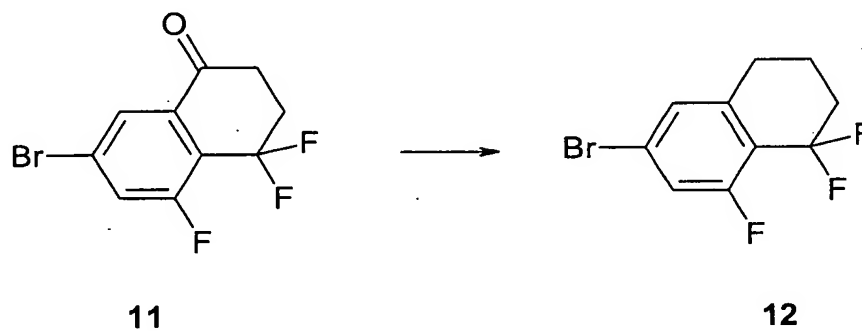


10

Ring closure of the fluorinated ester **10** to give compound **11** is carried out as described in Example 1.

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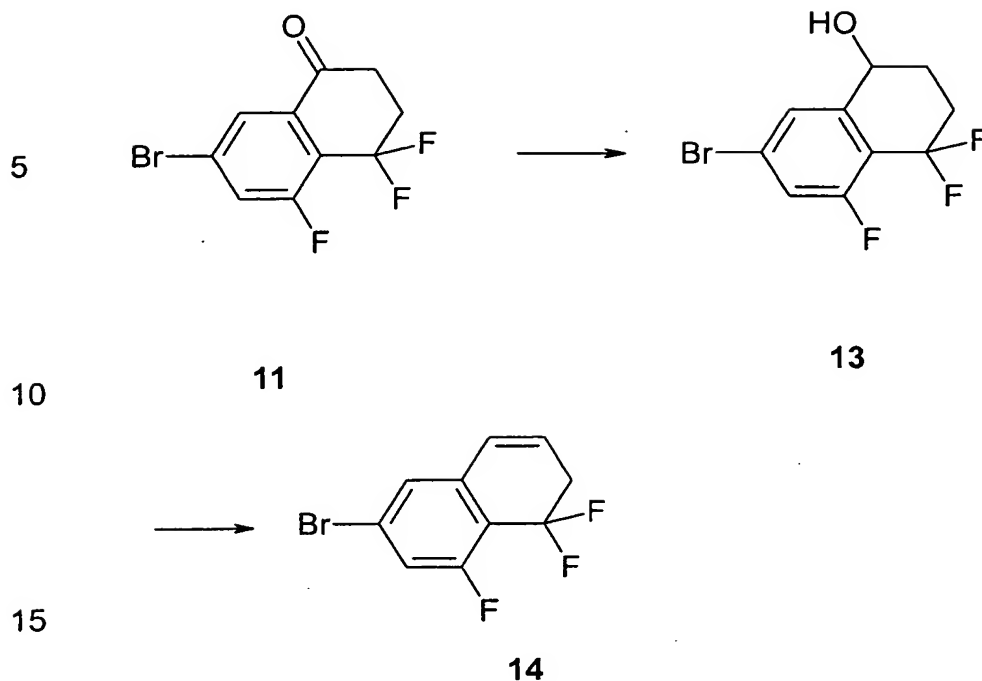
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Reduction to the alkane **12** is carried out as described in Example 1.

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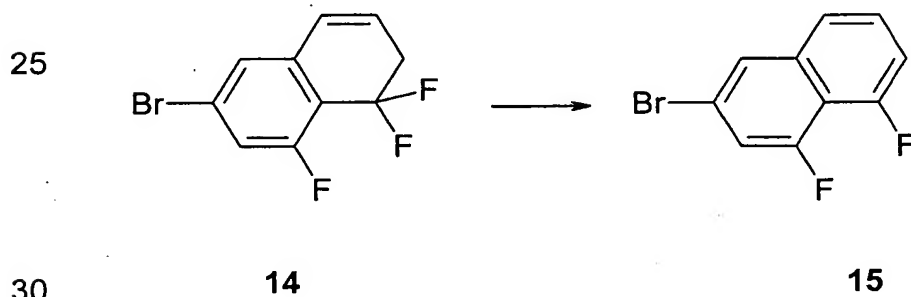
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- 35 -

Example 4

Reduction of compound **11** to the alcohol **13** and subsequent elimination of water to give the dihydronaphthalene derivative **14** are carried out as described in Example 2.

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Example 5

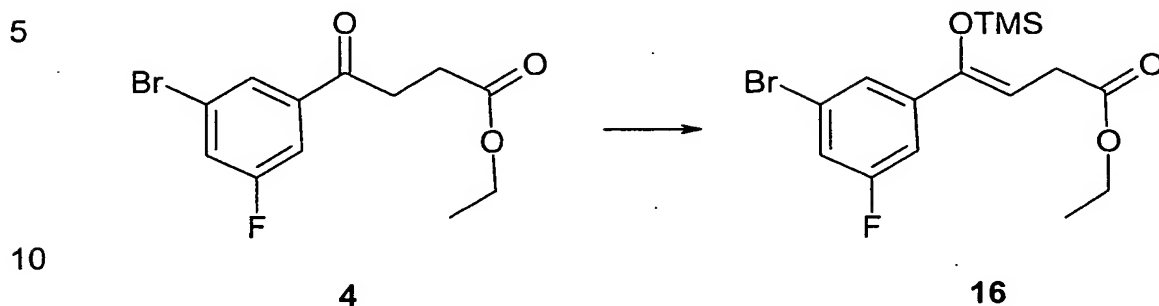
A solution of 9 g (34.2 mmol) of the dihydronaphthalene derivative **14** in 50 ml of THF is slowly added to a suspension of 4.5 g (40.1 mmol) of potassium tert-butoxide in 50 ml of THF, and the mixture is subsequently refluxed overnight. The cooled batch is diluted with water and extracted

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- 36 -

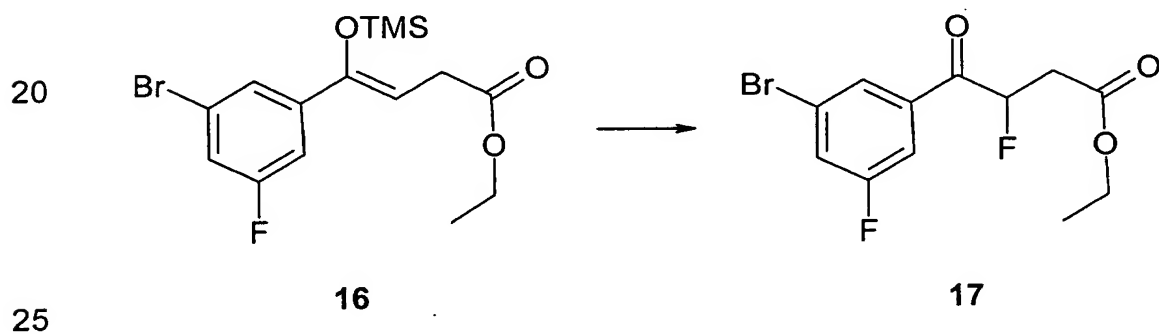
with diethyl ether. Drying, evaporation and chromatography on silica gel gives the naphthalene **15**.

Example 6



15

22 ml of a 2 M lithium diisopropylamide (LDA) solution are added at -78°C to a solution of 6.8 g (21.4 mmol) of the keto ester **4** in 80 ml of THF. After 1 hour, 2.6 g (24.0 mmol) of chlorotrimethylsilane are added. After thawing, the solvents are removed under reduced pressure, and the residue is employed in the subsequent step without further purification.

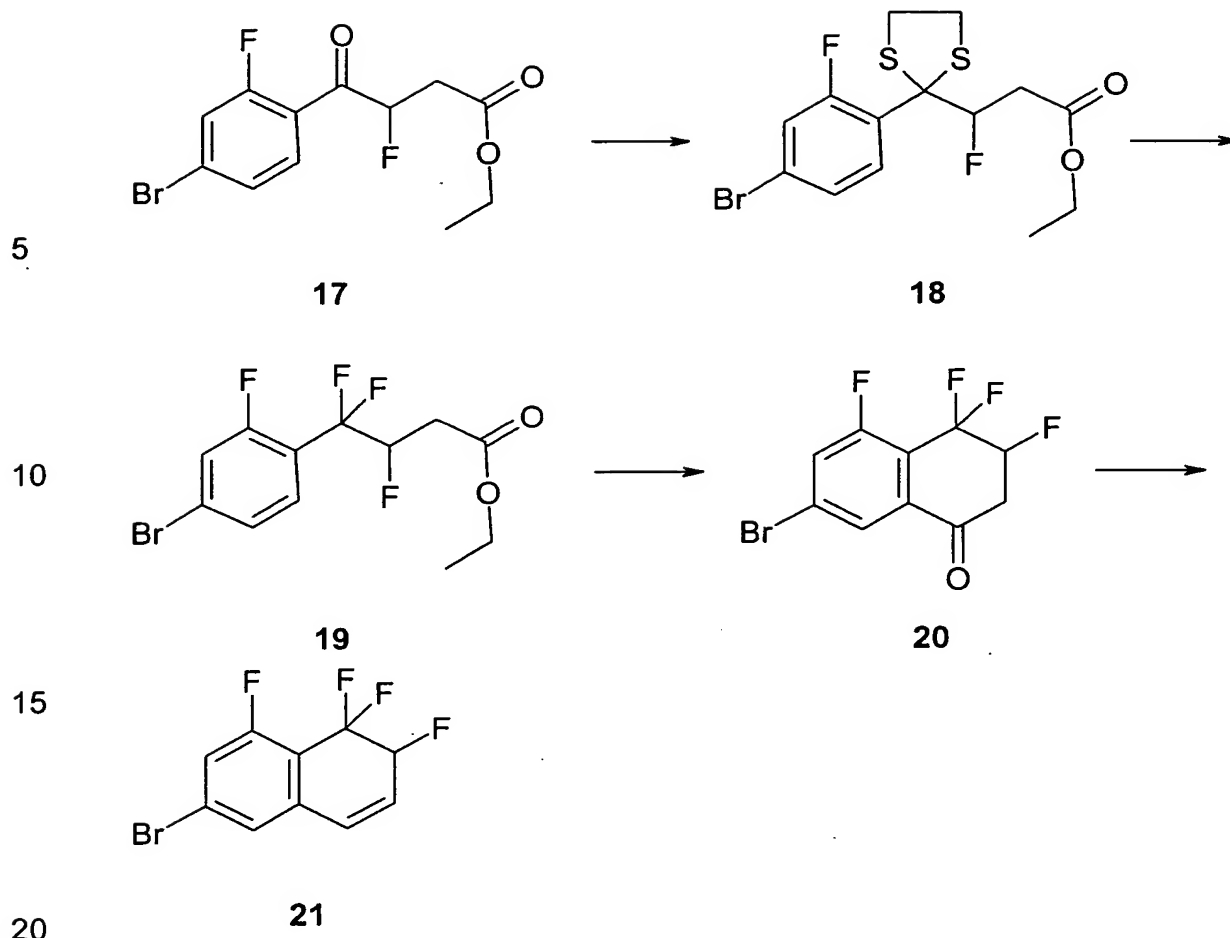


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4.9 g (19.8 mmol) of N-fluoropyridinium triflate are added to a solution of 5 g of the crude enol ether **16**, and the mixture is refluxed overnight. The solvent is removed under reduced pressure, and the residue is purified by chromatography on silica gel, giving the fluorinated product **17**.

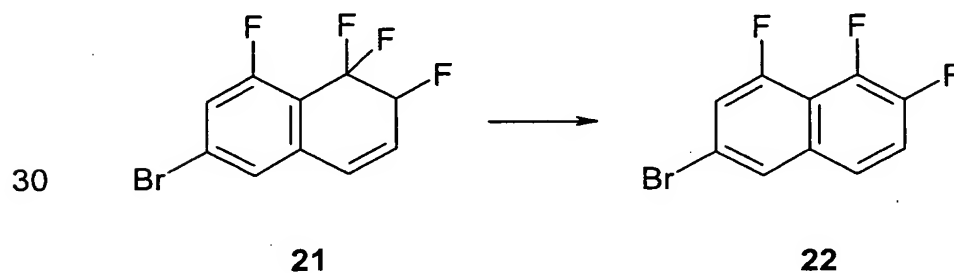
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- 37 -



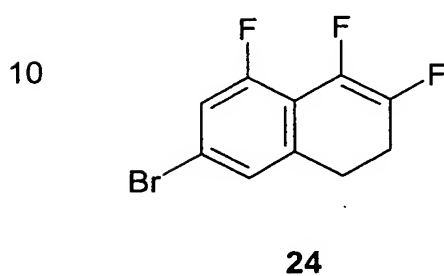
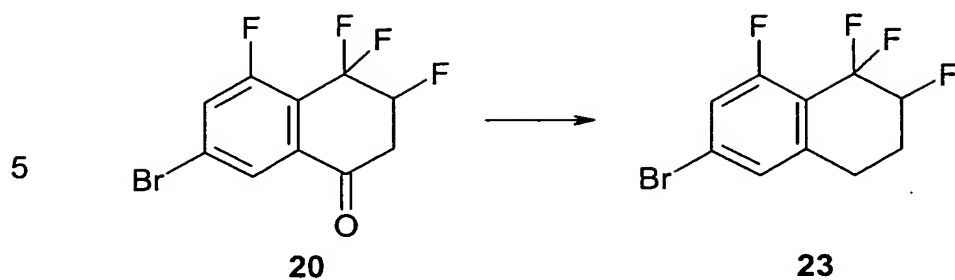
The conversions of the fluorinated product 17 into the dihydronaphthalene derivative 21 are carried out as already described in Examples 3 and 4.

25 Example 7



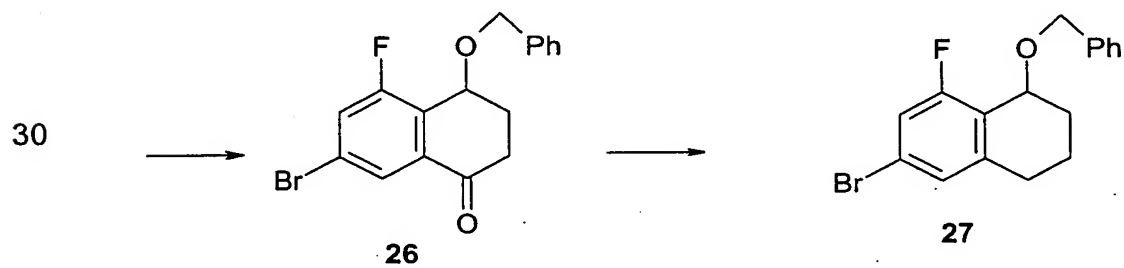
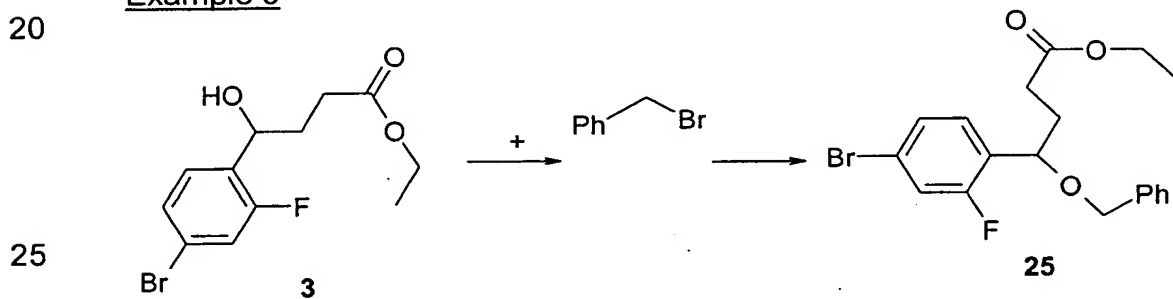
35 The conversion of the dihydronaphthalene derivative 21 into the naphthalene derivative 22 is carried out as already described in Example 5.

- 38 -

Example 8

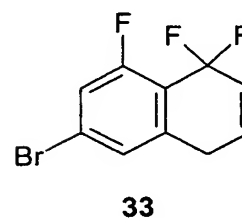
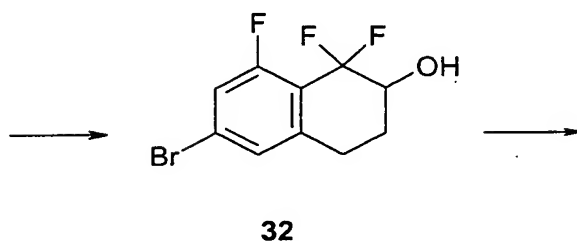
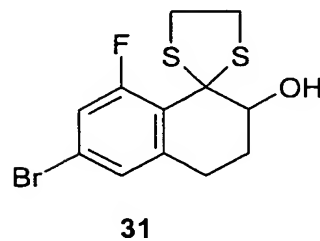
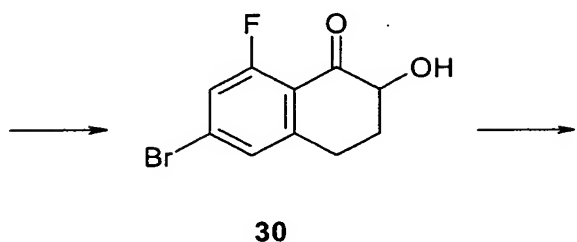
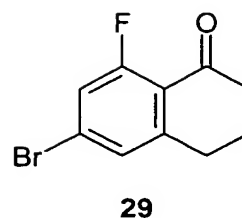
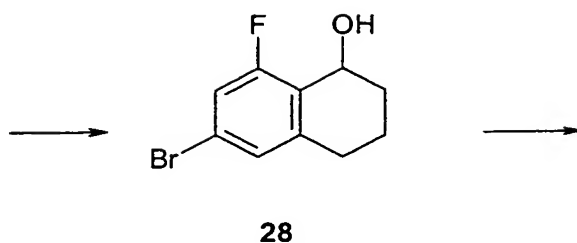
15

The conversion of compound **20** into the dihydronaphthalene derivative **24** is carried out as already described in Examples 4 and 5.

Example 9

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- 39 -



20 The hydroxy ester **3** is reacted with benzyl bromide in dimethylformamide (DMF) in the presence of potassium carbonate for four hours at 120°C. After cooling, the batch is added to ice-water and extracted with tert-butyl methyl (MTB) ether. Drying, evaporation and crystallisation gives the ester **25**.

25 The conversion of the ester **25** into the ketone **26** and the reduction thereof to the ether **27** takes place as described in Example 1.

30 The ether **27** dissolved in THF is reacted on palladium/carbon catalyst in a hydrogen atmosphere. Evaporation and chromatography on silica gel gives the hydroxyl compound **28**.

The conversion of the hydroxyl compound **28** into the ketone **29** is carried out as described in Example 1.

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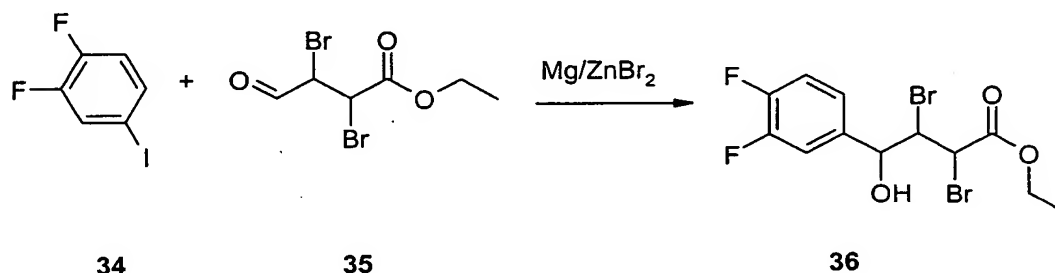
- 40 -

The ketone **29** is reacted with iodobenzene diacetate and KOH in methanol for four hours at from 0 to 20°C, giving the hydroxy ketone **30**.

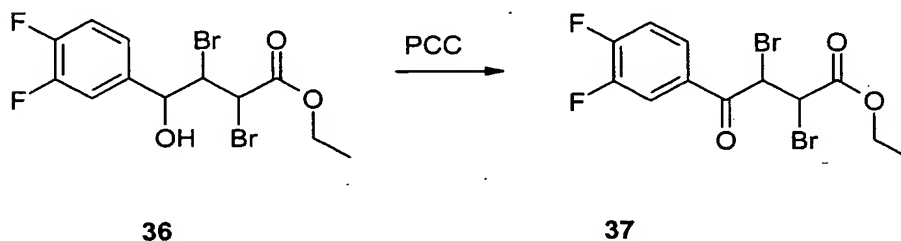
The conversion of the hydroxy ketone **30** into the dithiolane **31** and the conversion thereof into the fluorinated hydroxyl compound **32** take place as described in Example 3.

The fluorinated hydroxyl compound **32** is mixed with pyridine and POCl₃ with ice cooling. Alcohol is subsequently added. The reaction is carried out for four hours at 60°C. After cooling, the batch is added to ice-water and extracted with tert-butyl methyl (MTB) ether. Drying, evaporation and crystallisation gives the unsaturated fluorinated compound **33**.

Example 10



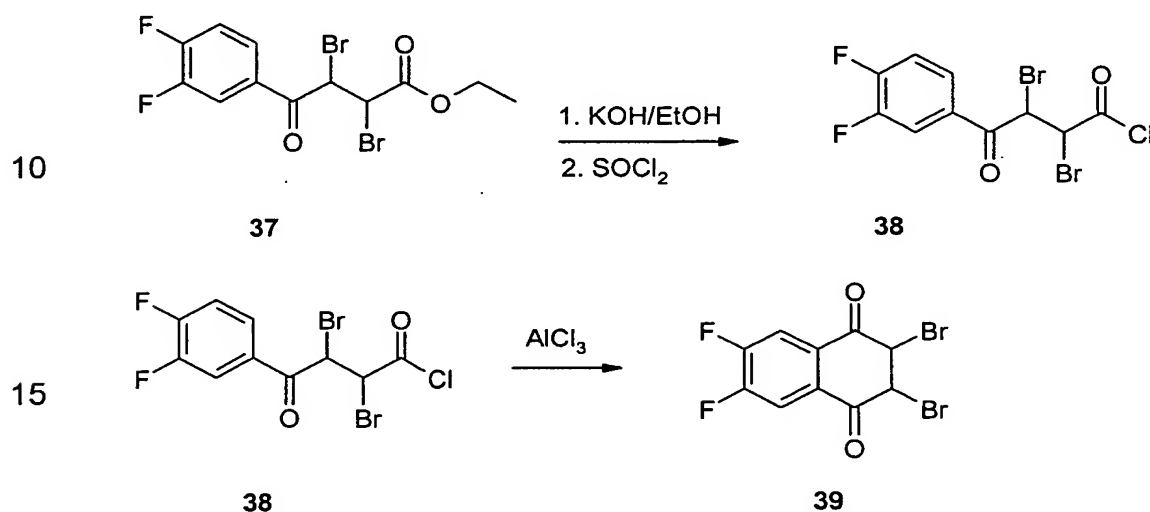
48.0 g (200 mmol) of the aromatic compound **34**, 4.8 g (200 mmol) of magnesium and 200 ml of toluene/THF (4:1) are used to prepare the corresponding Grignard compound. 22.5 g (100 mmol) of zinc bromide are subsequently introduced. After 1 hour, 57.6 g (200 mmol) of the aldehyde **35** in 50 ml of solvent are added. After a further 2 hours, water is added to the batch, and the latter is acidified with dil. HCl solution. The aqueous phase is extracted three times with MTB ether. Drying, evaporation and chromatography gives 60.4 g of the ester **36**.



- 41 -

A solution of 50 g (124 mmol) of the ester **36** in 100 ml of dichloromethane is added at room temperature to a suspension of 40.0 g (186 mmol) of pyridinium chlorochromate (PCC) and 80 g of Celite in 300 ml of dichloromethane, and the mixture is stirred until conversion is complete (TLC). Fil-

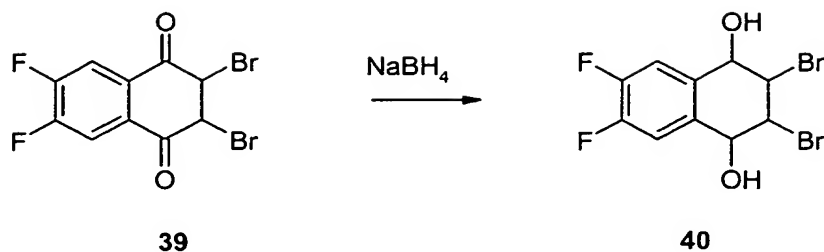
5 filtration, evaporation and chromatography gives 47.1 g of the oxo ester **37**.



45 g (113 mol) of the ester **37** are refluxed for 20 hours with a solution of 20 g of potassium hydroxide in 50 ml of water and 150 ml of ethanol. The alcohol is subsequently removed, and the residue is taken up with water and acidified using HCl solution. The aqueous phase is extracted three times with MTB ether. The organic phase is dried and evaporated. 20 ml of thionyl chloride are added to the residue, and the mixture is refluxed until the evolution of gas is complete. Excess thionyl chloride is distilled off, and the residue is employed in the next step without further purification.

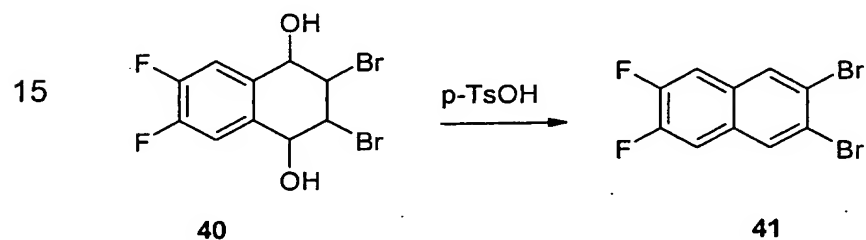
A solution of the acid chloride **38** in 50 ml of dichloromethane is added at -25°C to a suspension of 18.0 g (136 mmol) of aluminium chloride in 50 ml of dichloromethane. The batch is held at a temperature below -12°C until conversion is complete (TLC). The reaction is subsequently terminated by careful addition of water (50 ml). The precipitated solid is dissolved by means of HCl solution. The aqueous phase is extracted twice with dichloromethane, and the organic phase is dried and evaporated. Chromatography gives 30.2 g of the diketone **39**.

- 42 -



10

30.0 g (84.8 mmol) of the diketone **39** are dissolved in 150 ml of ethanol, and 6.3 g (170 mmol) of sodium borohydride are added in portions. When the reaction is complete (TLC), the batch is hydrolysed using water, the ethanol is removed under reduced pressure, and the residue is taken up in water and extracted with toluene. After evaporation, the product is employed in the next step without further purification.



20

The crude diol **40** is dissolved in 200 ml of toluene, 2 g of p -toluenesulfonic acid are added, and the mixture is refluxed until the separation of water is complete. Evaporation and filtration through silica gel gives 24.7 g of the naphthalene **41**.

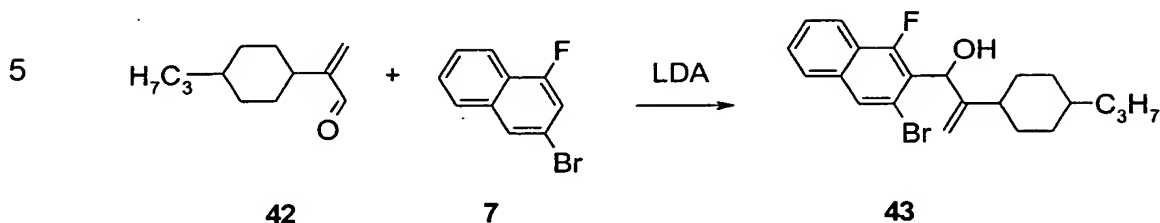
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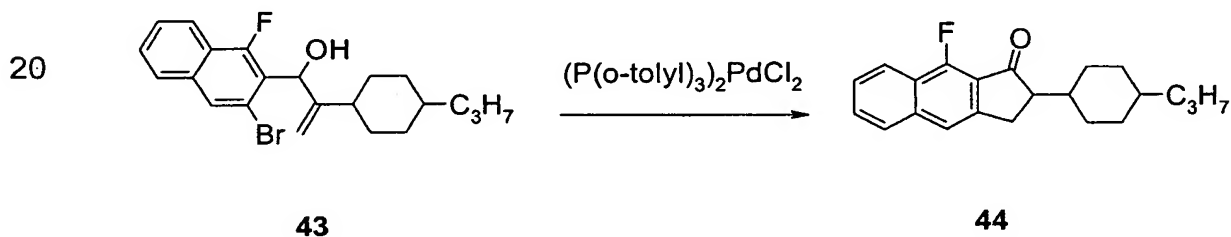
- 43 -

B) Preparation of the cyclopenta[b]naphthalene derivatives

Example 11

10 A solution of 13.5 g (60.0 mmol) of the bromofluoronaphthalene 7 in 10 ml of THF is added at -75°C to 27.0 ml of a solution, diluted with 100 ml of THF, of 2 N lithium diisopropylamide (LDA) in cyclohexane/ethylbenzene/THF (52.4 mmol). After 2 hours at the low temperature, 8.5 g (47.3 mmol) of the aldehyde 42 in 10 ml of THF are added. After 30 minutes, the cooling is removed, and 100 ml of 1 N HCl are added to the batch at 20°C.

15 Extraction of the aqueous phase, drying of the organic phase, evaporation and chromatography gives the allyl alcohol 43.

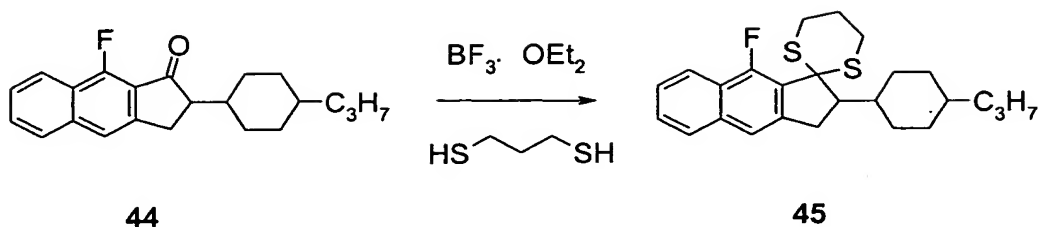


25 35.0 g (86.6 mmol) of the allyl alcohol 43, 5.5 g of bis(tri-*o*-tolylphosphine)-palladium dichloride and 50 ml of triethylamine are dissolved in 390 ml of acetonitrile, and the mixture is warmed at 90°C until the allyl alcohol has reacted completely. The cooled batch is added to water. Extraction, drying, evaporation and chromatography gives the ketone 44.

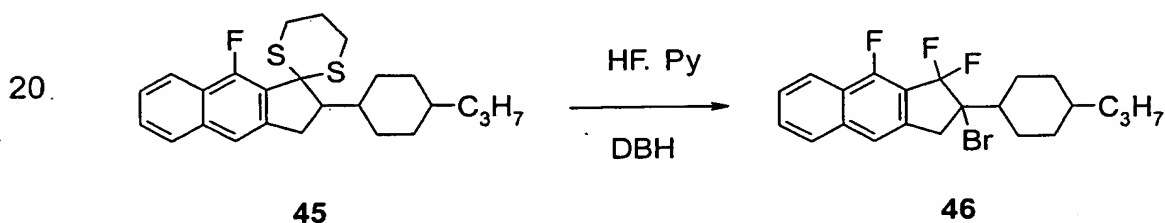
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- 44 -

Example 12

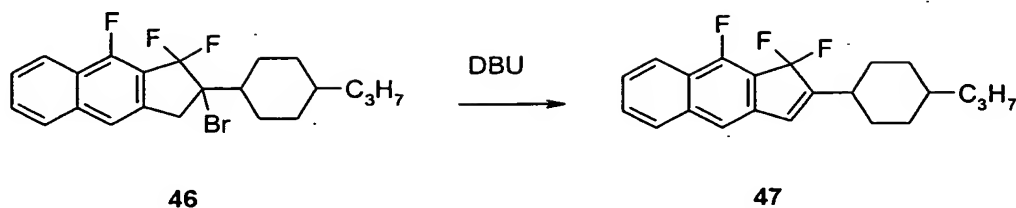
10.0 g (30.8 mmol) of the ketone **44** and 3.2 ml (31.0 mmol) of propane-
 10 dithiol are dissolved in 50 ml of dichloromethane, and 7.0 ml of boron tri-
 fluoride/diethyl ether complex are added at from 6 to 7°C, and the mixture
 is subsequently stirred overnight at room temperature. The batch is added
 to 10 ml of saturated sodium hydrogencarbonate solution and stirred until
 15 the evolution of gas is complete. After extraction of the aqueous phase,
 drying of the organic phase, evaporation and filtration through silica gel,
 the resultant residue is employed in the next step without further purifica-
 tion.



10.0 g of the crude thioketal **45** dissolved in 30 ml of dichloromethane are
 25 slowly added at -75°C to a mixture of 28.6 g (100 mmol) of 1,3-dibromo-
 5,5-dimethylhydantoin (DBH), 80 ml of a 65% solution of hydrogen fluoride
 in pyridine and 50 ml of dichloromethane. The batch is subsequently
 stirred overnight at room temperature. The reaction mixture is added to
 30 ice-cooled hydrogen sulfite solution and deacidified using saturated
 sodium hydrogencarbonate solution and sodium hydroxide solution.
 Extraction, drying, evaporation, re-washing with water, chromatography
 and crystallisation from hexane gives the cyclopenta[b]naphthalene
 derivative **46**.

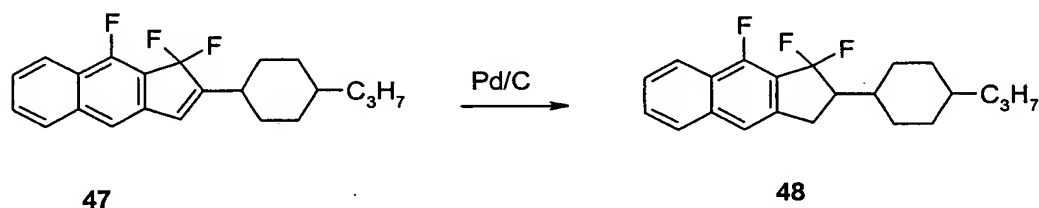
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- 45 -



6.0 g (14.1 mmol) of the cyclopenta[b]naphthalene derivative **46** are dissolved in 50 ml of dichloromethane, 2.4 ml (16.0 mmol) of 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) are added, and the mixture is stirred at room temperature until the starting material has reacted completely. The batch is washed with water and saturated sodium chloride solution, evaporated and subjected to chromatography. The cyclopenta[b]naphthalene derivative **47** is isolated.

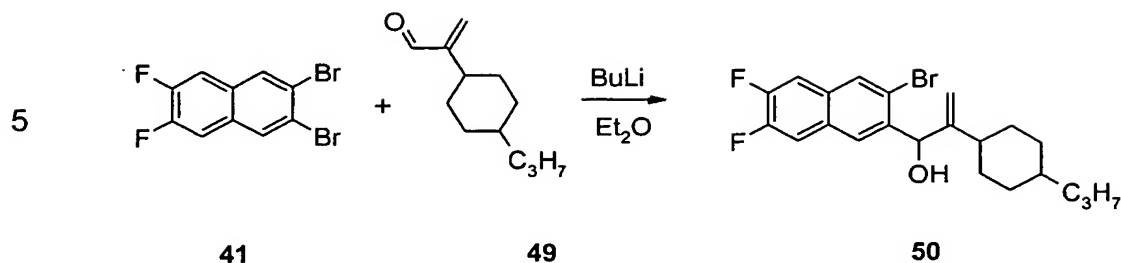
Example 13



4.0 g (11.6 mmol) of the cyclopenta[b]naphthalene derivative **47** are dissolved in 50 ml of THF and hydrogenated at room temperature and atmospheric pressure on a palladium catalyst. Evaporation, chromatography on silica gel and crystallisation gives the cyclopenta[b]naphthalene derivative **48**.

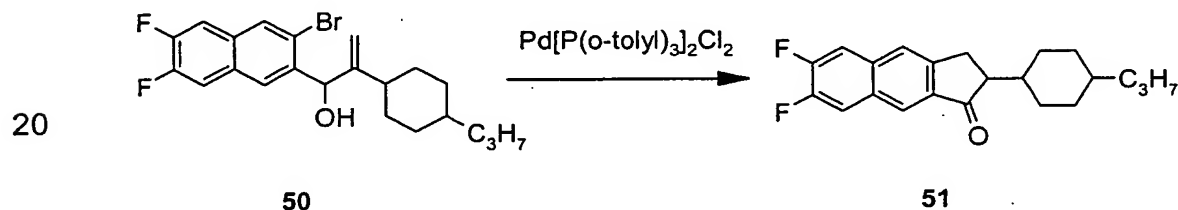
The Δn and $\Delta \epsilon$ values of the compound according to the invention were obtained by extrapolation from liquid-crystalline mixtures consisting of 5% of the compound according to the invention and 95% of one of the two commercially available liquid-crystal mixtures ZLI 4792 and ZLI 2857 (Merck, Darmstadt).

Δn : 0.1418 (ZLI 4792, 589 nm, 20°C)
 $\Delta \epsilon$: -4.9 (ZLI 2857, 1 kHz, 20°C)
 Clearing point: 158.6°C (ZLI 4792)

Example 14

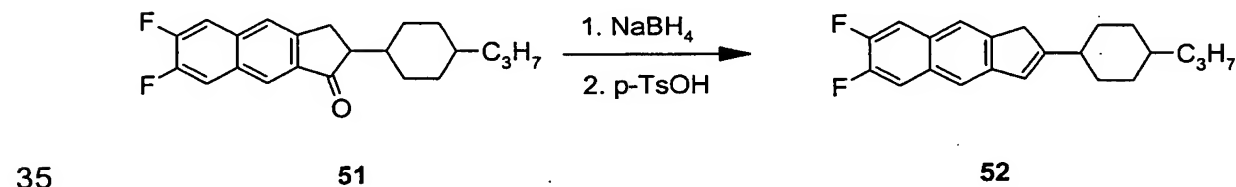
10 38.0 ml of an *n*-butyllithium solution in *n*-hexane are added at -75°C to a solution of 20.0 g (62.1 mmol) of the naphthalene **41** in 100 ml of diethyl ether, and the mixture is stirred for 1 hour. 11.2 g (62.1 mmol) of the aldehyde **49** in 50 ml of diethyl ether are subsequently added, and the mixture is stirred overnight. Water is added to the batch. The aqueous phase is

15 extracted with diethyl ether, and the organic phase is dried and evaporated. Chromatography gives 21.2 g of the allyl alcohol **50**.



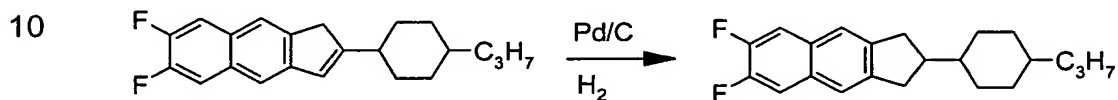
25 20.0 g (47.2 mmol) of the allyl alcohol **50** are dissolved in 175 ml of acetonitrile and 25 ml of triethylamine, 2.5 g of bis-tri-*o*-tolylphosphinepalladium(II) chloride are added, and the mixture is warmed at 90°C until the starting material has disappeared (HPLC). The batch is subsequently added to saturated sodium chloride solution. Extraction with MTB ether, drying, evaporation and chromatography on silica gel gives 10.5 g of the

30 ketone **51**.



- 47 -

10.0 g (29.2 mmol) of the ketone **51** are dissolved in 75 ml of ethanol, and 3.2 g (86 mmol) of sodium borohydride are added in portions. When the reaction is complete (TLC), the batch is hydrolysed using water, the ethanol is removed under reduced pressure, and the residue is taken up in water and extracted with toluene. After evaporation, the product is employed in the next step without further purification. The crude alcohol is dissolved in 100 ml of toluene, 1 g of *p*-toluenesulfonic acid is added, and the mixture is refluxed until the separation of water is complete. Evaporation and filtration through silica gel gives 8.5 g of the naphthalene **52**.



8.0 g (25.5 mmol) of the naphthalene **52** are dissolved in 50 ml of THF and hydrogenated on a palladium catalyst. Evaporation and chromatography on silica gel gives 7.9 g of the hydrogenated substance **53**.

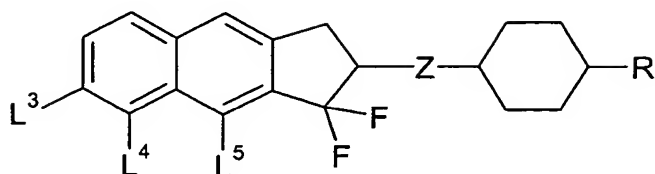
The following compounds are prepared analogously to Examples 1 to 14 or analogously to known synthetic steps:

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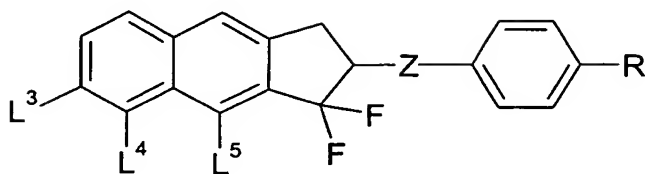
Examples 15 to 29

Example	L ³	L ⁴	L ⁵	Z	R
15	H	H	F	Bd.	CH ₃
16	H	F	F	Bd.	C ₂ H ₅
17	H	F	F	Bd.	C ₃ H ₇
18	F	F	F	Bd.	C ₃ H ₇
19	F	F	F	Bd.	C ₄ H ₉
20	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
21	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
22	H	H	F	-CF ₂ CF ₂ -	CH ₃
23	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
24	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
25	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
26	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
27	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
28	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
29	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

Examples 30 to 53

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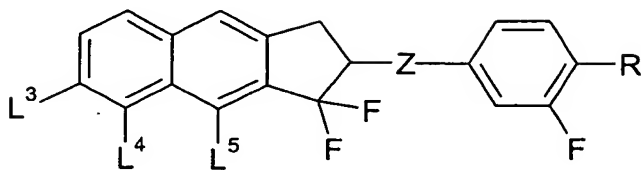
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Example	L ³	L ⁴	L ⁵	Z	R
30	H	H	F	Bd.	CH ₃
31	H	H	F	Bd.	C ₃ H ₇
32	H	F	F	Bd.	C ₂ H ₅
33	H	F	F	Bd.	C ₃ H ₇
34	F	F	F	Bd.	C ₃ H ₇
35	F	F	F	Bd.	C ₄ H ₉
36	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
37	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
38	H	H	F	-CF ₂ O-	CH ₃
39	H	H	F	-CF ₂ O-	C ₃ H ₇
40	H	F	F	-CF ₂ O-	C ₂ H ₅
41	H	F	F	-CF ₂ O-	C ₃ H ₇
42	F	F	F	-CF ₂ O-	C ₃ H ₇
43	F	F	F	-CF ₂ O-	C ₄ H ₉
44	OC ₂ H ₅	F	F	-CF ₂ O-	C ₃ H ₇
45	OC ₂ H ₅	F	F	-CF ₂ O-	C ₅ H ₁₁
46	H	H	F	-CF ₂ CF ₂ -	CH ₃
47	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
48	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
49	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
50	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
51	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
52	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
53	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

- 50 -

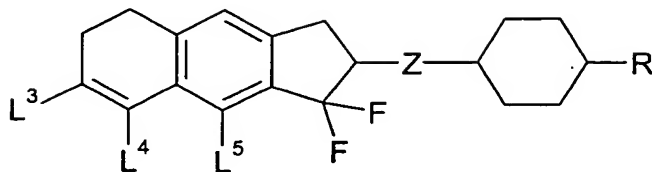
Examples 54 to 77

Example	L ³	L ⁴	L ⁵	Z	R
54	H	H	F	Bd.	CH ₃
55	H	H	F	Bd.	C ₃ H ₇
56	H	F	F	Bd.	C ₂ H ₅
57	H	F	F	Bd.	C ₃ H ₇
58	F	F	F	Bd.	C ₃ H ₇
59	F	F	F	Bd.	C ₄ H ₉
60	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
61	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
62	H	H	F	-CF ₂ O-	CH ₃
63	H	H	F	-CF ₂ O-	C ₃ H ₇
64	H	F	F	-CF ₂ O-	C ₂ H ₅
65	H	F	F	-CF ₂ O-	C ₃ H ₇
66	F	F	F	-CF ₂ O-	C ₃ H ₇
67	F	F	F	-CF ₂ O-	C ₄ H ₉
68	OC ₂ H ₅	F	F	-CF ₂ O-	C ₃ H ₇
69	OC ₂ H ₅	F	F	-CF ₂ O-	C ₅ H ₁₁
70	H	H	F	-CF ₂ CF ₂ -	CH ₃
71	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
72	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
73	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
74	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
75	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
76	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
77	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

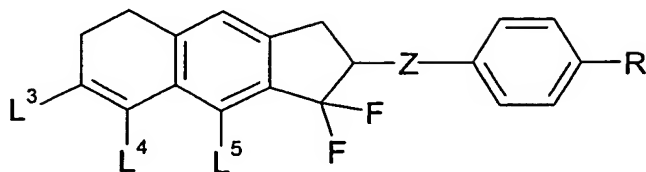
- 51 -

Examples 78 to 93



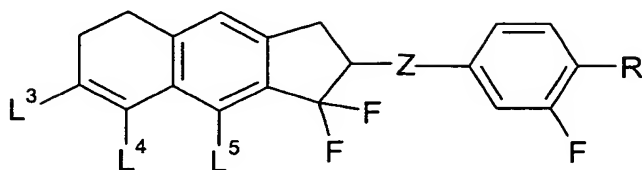
Example	L ³	L ⁴	L ⁵	Z	R
78	H	H	F	Bd.	CH ₃
79	H	H	F	Bd.	C ₃ H ₇
80	H	F	F	Bd.	C ₂ H ₅
81	H	F	F	Bd.	C ₃ H ₇
82	F	F	F	Bd.	C ₃ H ₇
83	F	F	F	Bd.	C ₄ H ₉
84	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
85	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
86	H	H	F	-CF ₂ CF ₂ -	CH ₃
87	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
88	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
89	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
90	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
91	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
92	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
93	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

Examples 94 to 117

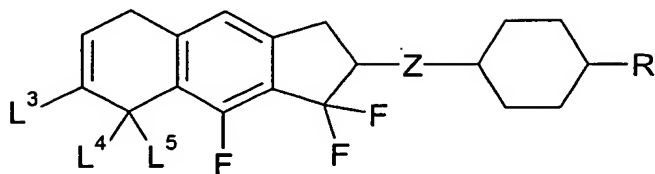
Example	L ³	L ⁴	L ⁵	Z	R
94	H	H	F	Bd.	CH ₃
95	H	H	F	Bd.	C ₃ H ₇
96	H	F	F	Bd.	C ₂ H ₅
97	H	F	F	Bd.	C ₃ H ₇
98	F	F	F	Bd.	C ₃ H ₇
99	F	F	F	Bd.	C ₄ H ₉
100	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
101	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
102	H	H	F	-CF ₂ O-	CH ₃
103	H	H	F	-CF ₂ O-	C ₃ H ₇
104	H	F	F	-CF ₂ O-	C ₂ H ₅
105	H	F	F	-CF ₂ O-	C ₃ H ₇
106	F	F	F	-CF ₂ O-	C ₃ H ₇
107	F	F	F	-CF ₂ O-	C ₄ H ₉
108	OC ₂ H ₅	F	F	-CF ₂ O-	C ₃ H ₇
109	OC ₂ H ₅	F	F	-CF ₂ O-	C ₅ H ₁₁
110	H	H	F	-CF ₂ CF ₂ -	CH ₃
111	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
112	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
113	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
114	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
115	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
116	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
117	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

Examples 118 to 141

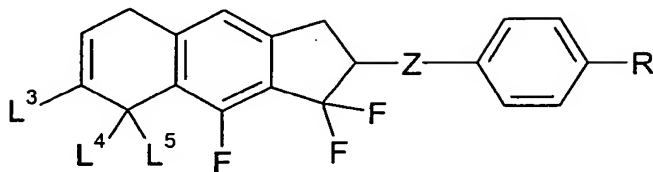
Example	L ³	L ⁴	L ⁵	Z	R
118	H	H	F	Bd.	CH ₃
119	H	H	F	Bd.	C ₃ H ₇
120	H	F	F	Bd.	C ₂ H ₅
121	H	F	F	Bd.	C ₃ H ₇
122	F	F	F	Bd.	C ₃ H ₇
123	F	F	F	Bd.	C ₄ H ₉
124	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
125	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
126	H	H	F	-CF ₂ O-	CH ₃
127	H	H	F	-CF ₂ O-	C ₃ H ₇
128	H	F	F	-CF ₂ O-	C ₂ H ₅
129	H	F	F	-CF ₂ O-	C ₃ H ₇
130	F	F	F	-CF ₂ O-	C ₃ H ₇
131	F	F	F	-CF ₂ O-	C ₄ H ₉
132	OC ₂ H ₅	F	F	-CF ₂ O-	C ₃ H ₇
133	OC ₂ H ₅	F	F	-CF ₂ O-	C ₅ H ₁₁
134	H	H	F	-CF ₂ CF ₂ -	CH ₃
135	H	H	F	-CF ₂ CF ₂ -	C ₃ H ₇
136	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
137	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
138	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
139	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
140	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
141	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

Examples 142 to 157

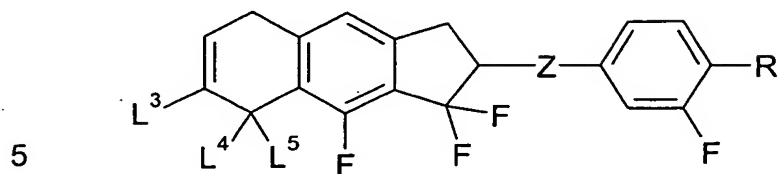
Example	L^3	L^4	L^5	Z	R
142	H	H	H	Bd.	CH_3
143	H	H	H	Bd.	C_3H_7
144	H	F	F	Bd.	C_2H_5
145	H	F	F	Bd.	C_3H_7
146	F	F	F	Bd.	C_3H_7
147	F	F	F	Bd.	C_4H_9
148	OC_2H_5	F	F	Bd.	C_3H_7
149	OC_2H_5	F	F	Bd.	C_5H_{11}
150	H	H	H	$-CF_2CF_2-$	CH_3
151	H	H	H	$-CF_2CF_2-$	C_3H_7
152	H	F	F	$-CF_2CF_2-$	C_2H_5
153	H	F	F	$-CF_2CF_2-$	C_3H_7
154	F	F	F	$-CF_2CF_2-$	C_3H_7
155	F	F	F	$-CF_2CF_2-$	C_4H_9
156	OC_2H_5	F	F	$-CF_2CF_2-$	C_3H_7
157	OC_2H_5	F	F	$-CF_2CF_2-$	C_5H_{11}

Bd. = single bond

Examples 158 to 181

Example	L^3	L^4	L^5	Z	R
158	H	H	H	Bd.	CH_3
159	H	H	H	Bd.	C_3H_7
160	H	F	F	Bd.	C_2H_5
161	H	F	F	Bd.	C_3H_7
162	F	F	F	Bd.	C_3H_7
163	F	F	F	Bd.	C_4H_9
164	OC_2H_5	F	F	Bd.	C_3H_7
165	OC_2H_5	F	F	Bd.	C_5H_{11}
166	H	H	H	$-CF_2O-$	CH_3
167	H	H	H	$-CF_2O-$	C_3H_7
168	H	F	F	$-CF_2O-$	C_2H_5
169	H	F	F	$-CF_2O-$	C_3H_7
170	F	F	F	$-CF_2O-$	C_3H_7
171	F	F	F	$-CF_2O-$	C_4H_9
172	OC_2H_5	F	F	$-CF_2O-$	C_3H_7
173	OC_2H_5	F	F	$-CF_2O-$	C_5H_{11}
174	H	H	H	$-CF_2CF_2-$	CH_3
175	H	H	H	$-CF_2CF_2-$	C_3H_7
176	H	F	F	$-CF_2CF_2-$	C_2H_5
177	H	F	F	$-CF_2CF_2-$	C_3H_7
178	F	F	F	$-CF_2CF_2-$	C_3H_7
179	F	F	F	$-CF_2CF_2-$	C_4H_9
180	OC_2H_5	F	F	$-CF_2CF_2-$	C_3H_7
181	OC_2H_5	F	F	$-CF_2CF_2-$	C_5H_{11}

Bd. = single bond

Examples 182 to 205

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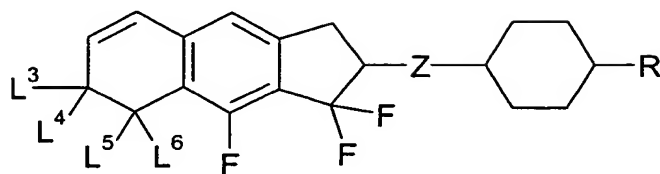
Example	L ³	L ⁴	L ⁵	Z	R
182	H	H	H	Bd.	CH ₃
183	H	H	H	Bd.	C ₃ H ₇
184	H	F	F	Bd.	C ₂ H ₅
185	H	F	F	Bd.	C ₃ H ₇
186	F	F	F	Bd.	C ₃ H ₇
187	F	F	F	Bd.	C ₄ H ₉
188	OC ₂ H ₅	F	F	Bd.	C ₃ H ₇
189	OC ₂ H ₅	F	F	Bd.	C ₅ H ₁₁
190	H	H	H	-CF ₂ O-	CH ₃
191	H	H	H	-CF ₂ O-	C ₃ H ₇
192	H	F	F	-CF ₂ O-	C ₂ H ₅
193	H	F	F	-CF ₂ O-	C ₃ H ₇
194	F	F	F	-CF ₂ O-	C ₃ H ₇
195	F	F	F	-CF ₂ O-	C ₄ H ₉
196	OC ₂ H ₅	F	F	-CF ₂ O-	C ₃ H ₇
197	OC ₂ H ₅	F	F	-CF ₂ O-	C ₅ H ₁₁
198	H	H	H	-CF ₂ CF ₂ -	CH ₃
199	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
200	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
201	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
202	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
203	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉
204	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
205	OC ₂ H ₅	F	F	-CF ₂ CF ₂ -	C ₅ H ₁₁

Bd. = single bond

- 57 -

Examples 206 to 217

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Example	L ³	L ⁴	L ⁵	L ⁶	Z	R
206	H	H	H	H	Bd.	CH ₃
207	H	H	H	H	Bd.	C ₃ H ₇
208	H	H	F	F	Bd.	C ₂ H ₅
209	H	H	F	F	Bd.	C ₃ H ₇
210	F	F	F	F	Bd.	C ₃ H ₇
211	F	F	F	F	Bd.	C ₄ H ₉
212	H	H	H	H	-CF ₂ CF ₂ -	CH ₃
213	H	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
214	H	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
215	H	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
216	F	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
217	F	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉

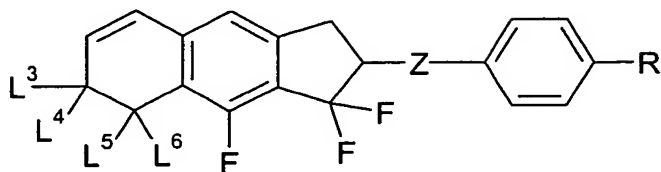
Bd. = single bond

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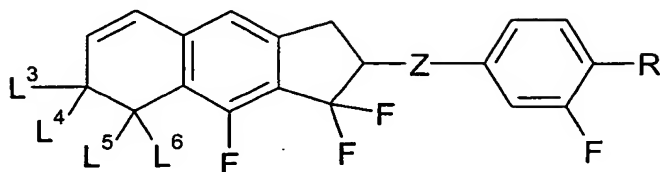
35

- 58 -

Examples 218 to 235

Example	L^3	L^4	L^5	L^6	Z	R
218	H	H	H	H	Bd.	CH_3
219	H	H	H	H	Bd.	C_3H_7
220	H	H	F	F	Bd.	C_2H_5
221	H	H	F	F	Bd.	C_3H_7
222	F	F	F	F	Bd.	C_3H_7
223	F	F	F	F	Bd.	C_4H_9
224	H	H	H	H	$-CF_2O-$	CH_3
225	H	H	H	H	$-CF_2O-$	C_3H_7
226	H	H	F	F	$-CF_2O-$	C_2H_5
227	H	H	F	F	$-CF_2O-$	C_3H_7
228	F	F	F	F	$-CF_2O-$	C_3H_7
229	F	F	F	F	$-CF_2O-$	C_4H_9
230	H	H	H	H	$-CF_2CF_2-$	CH_3
231	H	H	H	H	$-CF_2CF_2-$	C_3H_7
232	H	H	F	F	$-CF_2CF_2-$	C_2H_5
233	H	H	F	F	$-CF_2CF_2-$	C_3H_7
234	F	F	F	F	$-CF_2CF_2-$	C_3H_7
235	F	F	F	F	$-CF_2CF_2-$	C_4H_9

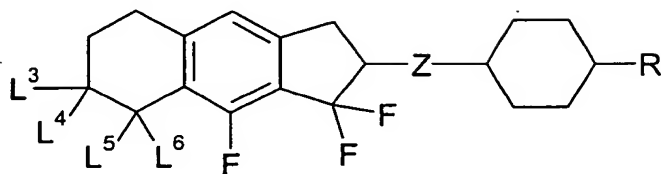
Bd. = single bond

Examples 236 to 253

Example	L^3	L^4	L^5	L^6	Z	R
236	H	H	H	H	Bd.	CH ₃
237	H	H	H	H	Bd.	C ₃ H ₇
238	H	H	F	F	Bd.	C ₂ H ₅
239	H	H	F	F	Bd.	C ₃ H ₇
240	F	F	F	F	Bd.	C ₃ H ₇
241	F	F	F	F	Bd.	C ₄ H ₉
242	H	H	H	H	-CF ₂ O-	CH ₃
243	H	H	H	H	-CF ₂ O-	C ₃ H ₇
244	H	H	F	F	-CF ₂ O-	C ₂ H ₅
245	H	H	F	F	-CF ₂ O-	C ₃ H ₇
246	F	F	F	F	-CF ₂ O-	C ₃ H ₇
247	F	F	F	F	-CF ₂ O-	C ₄ H ₉
248	H	H	H	H	-CF ₂ CF ₂ -	CH ₃
249	H	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
250	H	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
251	H	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
252	F	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
253	F	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉

Bd. = single bond

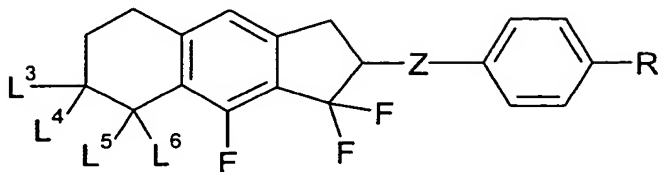
- 60 -

Examples 254 to 265

Example	L ³	L ⁴	L ⁵	L ⁶	Z	R
254	H	H	H	H	Bd.	CH ₃
255	H	H	H	H	Bd.	C ₃ H ₇
256	H	H	F	F	Bd.	C ₂ H ₅
257	H	H	F	F	Bd.	C ₃ H ₇
258	F	F	F	F	Bd.	C ₃ H ₇
259	F	F	F	F	Bd.	C ₄ H ₉
260	H	H	H	H	-CF ₂ CF ₂ -	CH ₃
261	H	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
262	H	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
263	H	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
264	F	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
265	F	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉

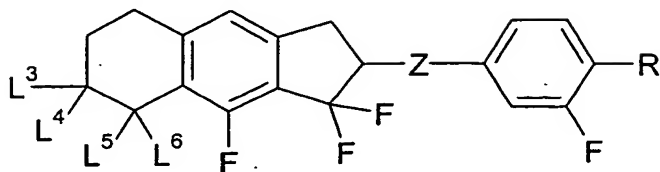
Bd. = single bond

- 61 -

Examples 266 to 283

Example	L ³	L ⁴	L ⁵	L ⁶	Z	R
266	H	H	H	H	Bd.	CH ₃
267	H	H	H	H	Bd.	C ₃ H ₇
268	H	H	F	F	Bd.	C ₂ H ₅
269	H	H	F	F	Bd.	C ₃ H ₇
270	F	F	F	F	Bd.	C ₃ H ₇
271	F	F	F	F	Bd.	C ₄ H ₉
272	H	H	H	H	-CF ₂ O-	CH ₃
273	H	H	H	H	-CF ₂ O-	C ₃ H ₇
274	H	H	F	F	-CF ₂ O-	C ₂ H ₅
275	H	H	F	F	-CF ₂ O-	C ₃ H ₇
276	F	F	F	F	-CF ₂ O-	C ₃ H ₇
277	F	F	F	F	-CF ₂ O-	C ₄ H ₉
278	H	H	H	H	-CF ₂ CF ₂ -	CH ₃
279	H	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
280	H	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
281	H	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
282	F	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
283	F	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉

Bd. = single bond

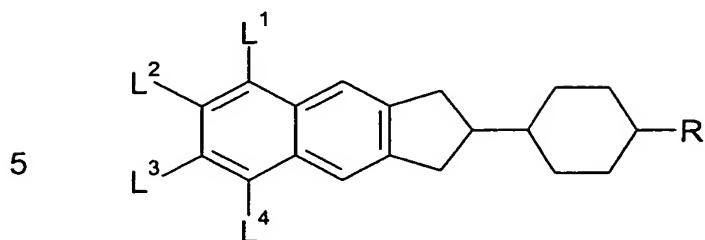
Examples 284 to 301

Example	L ³	L ⁴	L ⁵	L ⁶	Z	R
284	H	H	H	H	Bd.	CH ₃
285	H	H	H	H	Bd.	C ₃ H ₇
286	H	H	F	F	Bd.	C ₂ H ₅
287	H	H	F	F	Bd.	C ₃ H ₇
288	F	F	F	F	Bd.	C ₃ H ₇
289	F	F	F	F	Bd.	C ₄ H ₉
290	H	H	H	H	-CF ₂ O-	CH ₃
291	H	H	H	H	-CF ₂ O-	C ₃ H ₇
292	H	H	F	F	-CF ₂ O-	C ₂ H ₅
293	H	H	F	F	-CF ₂ O-	C ₃ H ₇
294	F	F	F	F	-CF ₂ O-	C ₃ H ₇
295	F	F	F	F	-CF ₂ O-	C ₄ H ₉
296	H	H	H	H	-CF ₂ CF ₂ -	CH ₃
297	H	H	H	H	-CF ₂ CF ₂ -	C ₃ H ₇
298	H	H	F	F	-CF ₂ CF ₂ -	C ₂ H ₅
299	H	H	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
300	F	F	F	F	-CF ₂ CF ₂ -	C ₃ H ₇
301	F	F	F	F	-CF ₂ CF ₂ -	C ₄ H ₉

Bd. = single bond

Table 1 $\Delta\epsilon$ and Δn values for substances of individual examples

Example No.	$\Delta\epsilon$	Δn
17	-6.3	0.143
18	-8.0	0.143
20	-7.3	0.166
79	-3.9	0.127
81	-9.1	0.117
82	-10.2	0.121
143	-3.3	0.091
145	-11.8	0.081
146	-9.2	0.081
207	-2.2	0.128
209	-9.6	0.115
210	-6.9	0.106
255	-3.0	0.095
257	-10.3	0.079
258	-7.9	0.079

Examples 302 to 337

Example	L ¹	L ²	L ³	L ⁴	R
302	H	F	H	H	CH ₃
303	H	F	H	H	C ₃ H ₇
304	H	F	H	H	C ₅ H ₁₁
305	H	F	F	H	C ₂ H ₅
306	H	F	F	H	C ₃ H ₇
307	H	F	F	H	C ₆ H ₁₃
308	F	F	F	F	CH ₃
309	F	F	F	F	C ₃ H ₇
310	F	F	F	F	C ₅ H ₁₁
311	H	CF ₃	H	H	C ₂ H ₅
312	H	CF ₃	H	H	C ₃ H ₇
313	H	CF ₃	H	H	C ₆ H ₁₃
314	H	OCF ₃	H	H	CH ₃
315	H	OCF ₃	H	H	C ₃ H ₇
316	H	OCF ₃	H	H	C ₅ H ₁₁
317	H	CN	H	H	C ₂ H ₅
318	H	CN	H	H	C ₃ H ₇
319	H	CN	H	H	C ₆ H ₁₃
320	H	CF ₃	F	H	C ₂ H ₅
321	H	CF ₃	F	H	C ₃ H ₇
322	H	CF ₃	F	H	C ₆ H ₁₃
323	H	OCF ₃	F	H	CH ₃
324	H	OCF ₃	F	H	C ₃ H ₇
325	H	OCF ₃	F	H	C ₅ H ₁₁

- 65 -

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Example	L ¹	L ²	L ³	L ⁴	R
326	H	CF ₃	CF ₃	H	C ₂ H ₅
327	H	CF ₃	CF ₃	H	C ₃ H ₇
328	H	CF ₃	CF ₃	H	C ₆ H ₁₃
329	H	CF ₃	OCF ₃	H	CH ₃
330	H	CF ₃	OCF ₃	H	C ₃ H ₇
331	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
332	H	OCF ₃	OCF ₃	H	C ₂ H ₅
333	H	OCF ₃	OCF ₃	H	C ₃ H ₇
334	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃
335	H	CN	CN	H	C ₂ H ₅
336	H	CN	CN	H	C ₃ H ₇
337	H	CN	CN	H	C ₆ H ₁₃

Table 2

 $\Delta\epsilon$ and Δn values for substances of individual examples

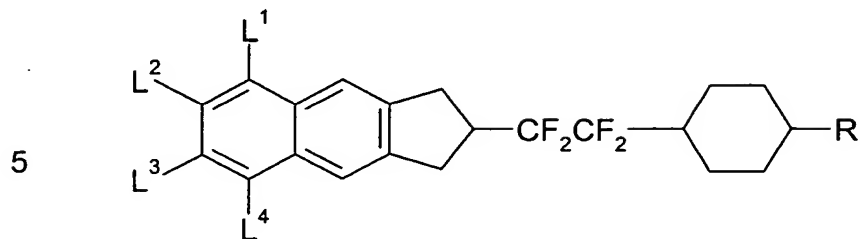
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Example No.	$\Delta\epsilon$	Δn
306	12.9	0.179
309	17.0	0.158
312	12.7	0.160
321	23.2	0.159
324	12.4	0.172
327	31.4	0.159
330	19.7	0.143
333	17.4	0.158

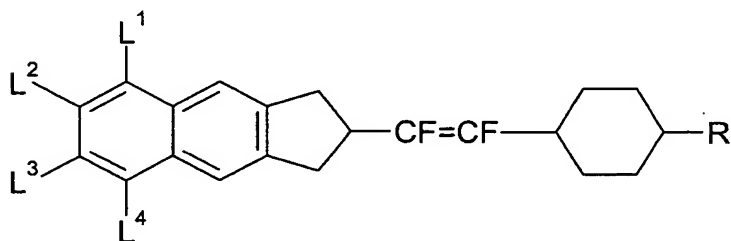
35

Examples 338 to 367

Example	L ¹	L ²	L ³	L ⁴	R
338	H	F	H	H	CH ₃
339	H	F	H	H	C ₃ H ₇
340	H	F	H	H	C ₅ H ₁₁
341	H	F	F	H	C ₂ H ₅
342	H	F	F	H	C ₃ H ₇
343	H	F	F	H	C ₆ H ₁₃
344	F	F	F	F	CH ₃
345	F	F	F	F	C ₃ H ₇
346	F	F	F	F	C ₅ H ₁₁
347	H	CF ₃	H	H	C ₂ H ₅
348	H	CF ₃	H	H	C ₃ H ₇
349	H	CF ₃	H	H	C ₆ H ₁₃
350	H	OCF ₃	H	H	CH ₃
351	H	OCF ₃	H	H	C ₃ H ₇
352	H	OCF ₃	H	H	C ₅ H ₁₁
353	H	CF ₃	F	H	C ₂ H ₅
354	H	CF ₃	F	H	C ₃ H ₇
355	H	CF ₃	F	H	C ₆ H ₁₃
356	H	OCF ₃	F	H	CH ₃
357	H	OCF ₃	F	H	C ₃ H ₇
358	H	OCF ₃	F	H	C ₅ H ₁₁
359	H	CF ₃	CF ₃	H	C ₂ H ₅
360	H	CF ₃	CF ₃	H	C ₃ H ₇
361	H	CF ₃	CF ₃	H	C ₆ H ₁₃

- 67 -

Example	L ¹	L ²	L ³	L ⁴	R
362	H	CF ₃	OCF ₃	H	CH ₃
363	H	CF ₃	OCF ₃	H	C ₃ H ₇
364	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
365	H	OCF ₃	OCF ₃	H	C ₂ H ₅
366	H	OCF ₃	OCF ₃	H	C ₃ H ₇
367	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 368 to 397

Example	L ¹	L ²	L ³	L ⁴	R
368	H	F	H	H	CH ₃
369	H	F	H	H	C ₃ H ₇
370	H	F	H	H	C ₅ H ₁₁
371	H	F	F	H	C ₂ H ₅
372	H	F	F	H	C ₃ H ₇
373	H	F	F	H	C ₆ H ₁₃
374	F	F	F	F	CH ₃
375	F	F	F	F	C ₃ H ₇
376	F	F	F	F	C ₅ H ₁₁
377	H	CF ₃	H	H	C ₂ H ₅
378	H	CF ₃	H	H	C ₃ H ₇
379	H	CF ₃	H	H	C ₆ H ₁₃
380	H	OCF ₃	H	H	CH ₃
381	H	OCF ₃	H	H	C ₃ H ₇
382	H	OCF ₃	H	H	C ₅ H ₁₁
383	H	CF ₃	F	H	C ₂ H ₅

- 68 -

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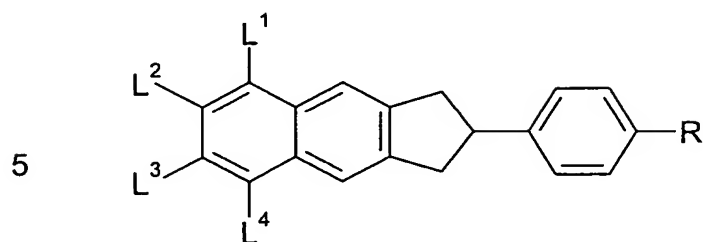
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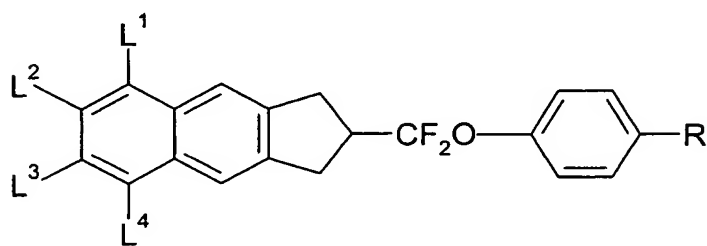
Example	L ¹	L ²	L ³	L ⁴	R
384	H	CF ₃	F	H	C ₃ H ₇
385	H	CF ₃	F	H	C ₆ H ₁₃
386	H	OCF ₃	F	H	CH ₃
387	H	OCF ₃	F	H	C ₃ H ₇
388	H	OCF ₃	F	H	C ₅ H ₁₁
389	H	CF ₃	CF ₃	H	C ₂ H ₅
390	H	CF ₃	CF ₃	H	C ₃ H ₇
391	H	CF ₃	CF ₃	H	C ₆ H ₁₃
392	H	CF ₃	OCF ₃	H	CH ₃
393	H	CF ₃	OCF ₃	H	C ₃ H ₇
394	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
395	H	OCF ₃	OCF ₃	H	C ₂ H ₅
396	H	OCF ₃	OCF ₃	H	C ₃ H ₇
397	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 398 to 427

	Example	L¹	L²	L³	L⁴	R
10	398	H	F	H	H	CH ₃
	399	H	F	H	H	C ₃ H ₇
	400	H	F	H	H	C ₅ H ₁₁
	401	H	F	F	H	C ₂ H ₅
15	402	H	F	F	H	C ₃ H ₇
	403	H	F	F	H	C ₆ H ₁₃
	404	F	F	F	F	CH ₃
	405	F	F	F	F	C ₃ H ₇
	406	F	F	F	F	C ₅ H ₁₁
20	407	H	CF ₃	H	H	C ₂ H ₅
	408	H	CF ₃	H	H	C ₃ H ₇
	409	H	CF ₃	H	H	C ₆ H ₁₃
	410	H	OCF ₃	H	H	CH ₃
25	411	H	OCF ₃	H	H	C ₃ H ₇
	412	H	OCF ₃	H	H	C ₅ H ₁₁
	413	H	CF ₃	F	H	C ₂ H ₅
	414	H	CF ₃	F	H	C ₃ H ₇
	415	H	CF ₃	F	H	C ₆ H ₁₃
30	416	H	OCF ₃	F	H	CH ₃
	417	H	OCF ₃	F	H	C ₃ H ₇
	418	H	OCF ₃	F	H	C ₅ H ₁₁
	419	H	CF ₃	CF ₃	H	C ₂ H ₅
35	420	H	CF ₃	CF ₃	H	C ₃ H ₇
	421	H	CF ₃	CF ₃	H	C ₆ H ₁₃

- 70 -

Example	L ¹	L ²	L ³	L ⁴	R
422	H	CF ₃	OCF ₃	H	CH ₃
423	H	CF ₃	OCF ₃	H	C ₃ H ₇
424	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
425	H	OCF ₃	OCF ₃	H	C ₂ H ₅
426	H	OCF ₃	OCF ₃	H	C ₃ H ₇
427	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 428 to 457

Example	L ¹	L ²	L ³	L ⁴	R
428	H	F	H	H	CH ₃
429	H	F	H	H	C ₃ H ₇
430	H	F	H	H	C ₅ H ₁₁
431	H	F	F	H	C ₂ H ₅
432	H	F	F	H	C ₃ H ₇
433	H	F	F	H	C ₆ H ₁₃
434	F	F	F	F	CH ₃
435	F	F	F	F	C ₃ H ₇
436	F	F	F	F	C ₅ H ₁₁
437	H	CF ₃	H	H	C ₂ H ₅
438	H	CF ₃	H	H	C ₃ H ₇
439	H	CF ₃	H	H	C ₆ H ₁₃
440	H	OCF ₃	H	H	CH ₃
441	H	OCF ₃	H	H	C ₃ H ₇
442	H	OCF ₃	H	H	C ₅ H ₁₁
443	H	CF ₃	F	H	C ₂ H ₅

- 71 -

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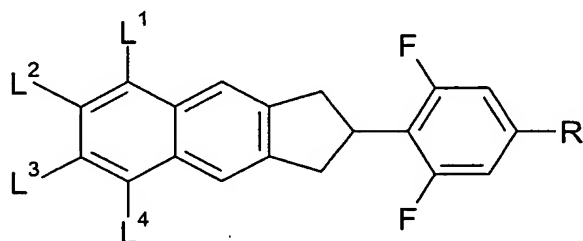
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Example	L ¹	L ²	L ³	L ⁴	R
444	H	CF ₃	F	H	C ₃ H ₇
445	H	CF ₃	F	H	C ₆ H ₁₃
446	H	OCF ₃	F	H	CH ₃
447	H	OCF ₃	F	H	C ₃ H ₇
448	H	OCF ₃	F	H	C ₅ H ₁₁
449	H	CF ₃	CF ₃	H	C ₂ H ₅
450	H	CF ₃	CF ₃	H	C ₃ H ₇
451	H	CF ₃	CF ₃	H	C ₆ H ₁₃
452	H	CF ₃	OCF ₃	H	CH ₃
453	H	CF ₃	OCF ₃	H	C ₃ H ₇
454	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
455	H	OCF ₃	OCF ₃	H	C ₂ H ₅
456	H	OCF ₃	OCF ₃	H	C ₃ H ₇
457	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 458 to 487

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Example	L ¹	L ²	L ³	L ⁴	R
458	H	F	H	H	CH ₃
459	H	F	H	H	C ₃ H ₇
460	H	F	H	H	C ₅ H ₁₁
461	H	F	F	H	C ₂ H ₅
462	H	F	F	H	C ₃ H ₇
463	H	F	F	H	C ₆ H ₁₃
464	F	F	F	F	CH ₃
465	F	F	F	F	C ₃ H ₇

- 72 -

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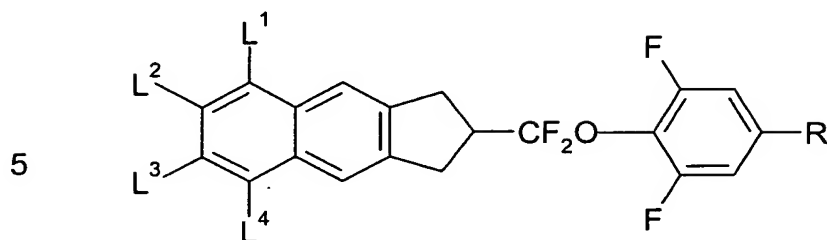
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Example	L ¹	L ²	L ³	L ⁴	R
466	F	F	F	F	C ₅ H ₁₁
467	H	CF ₃	H	H	C ₂ H ₅
468	H	CF ₃	H	H	C ₃ H ₇
469	H	CF ₃	H	H	C ₆ H ₁₃
470	H	OCF ₃	H	H	CH ₃
471	H	OCF ₃	H	H	C ₃ H ₇
472	H	OCF ₃	H	H	C ₅ H ₁₁
473	H	CF ₃	F	H	C ₂ H ₅
474	H	CF ₃	F	H	C ₃ H ₇
475	H	CF ₃	F	H	C ₆ H ₁₃
476	H	OCF ₃	F	H	CH ₃
477	H	OCF ₃	F	H	C ₃ H ₇
478	H	OCF ₃	F	H	C ₅ H ₁₁
479	H	CF ₃	CF ₃	H	C ₂ H ₅
480	H	CF ₃	CF ₃	H	C ₃ H ₇
481	H	CF ₃	CF ₃	H	C ₆ H ₁₃
482	H	CF ₃	OCF ₃	H	CH ₃
483	H	CF ₃	OCF ₃	H	C ₃ H ₇
484	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
485	H	OCF ₃	OCF ₃	H	C ₂ H ₅
486	H	OCF ₃	OCF ₃	H	C ₃ H ₇
487	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

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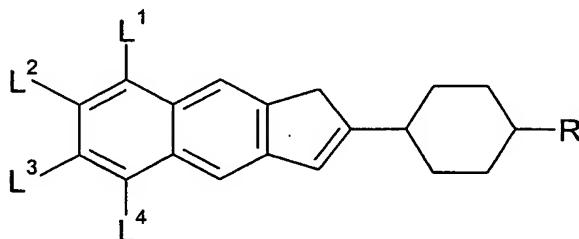
Examples 488 to 517

Example	L ¹	L ²	L ³	L ⁴	R
488	H	F	H	H	CH ₃
489	H	F	H	H	C ₃ H ₇
490	H	F	H	H	C ₅ H ₁₁
491	H	F	F	H	C ₂ H ₅
492	H	F	F	H	C ₃ H ₇
493	H	F	F	H	C ₆ H ₁₃
494	F	F	F	F	CH ₃
495	F	F	F	F	C ₃ H ₇
496	F	F	F	F	C ₅ H ₁₁
497	H	CF ₃	H	H	C ₂ H ₅
498	H	CF ₃	H	H	C ₃ H ₇
499	H	CF ₃	H	H	C ₆ H ₁₃
500	H	OCF ₃	H	H	CH ₃
501	H	OCF ₃	H	H	C ₃ H ₇
502	H	OCF ₃	H	H	C ₅ H ₁₁
503	H	CF ₃	F	H	C ₂ H ₅
504	H	CF ₃	F	H	C ₃ H ₇
505	H	CF ₃	F	H	C ₆ H ₁₃
506	H	OCF ₃	F	H	CH ₃
507	H	OCF ₃	F	H	C ₃ H ₇
508	H	OCF ₃	F	H	C ₅ H ₁₁
509	H	CF ₃	CF ₃	H	C ₂ H ₅
510	H	CF ₃	CF ₃	H	C ₃ H ₇
511	H	CF ₃	CF ₃	H	C ₆ H ₁₃

- 74 -

Example	L ¹	L ²	L ³	L ⁴	R
512	H	CF ₃	OCF ₃	H	CH ₃
513	H	CF ₃	OCF ₃	H	C ₃ H ₇
514	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
515	H	OCF ₃	OCF ₃	H	C ₂ H ₅
516	H	OCF ₃	OCF ₃	H	C ₃ H ₇
517	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

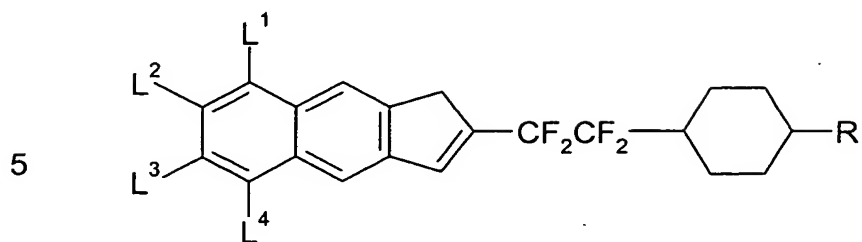
Examples 518 to 547



Example	L ¹	L ²	L ³	L ⁴	R
518	H	F	H	H	CH ₃
519	H	F	H	H	C ₃ H ₇
520	H	F	H	H	C ₅ H ₁₁
521	H	F	F	H	C ₂ H ₅
522	H	F	F	H	C ₃ H ₇
523	H	F	F	H	C ₆ H ₁₃
524	F	F	F	F	CH ₃
525	F	F	F	F	C ₃ H ₇
526	F	F	F	F	C ₅ H ₁₁
527	H	CF ₃	H	H	C ₂ H ₅
528	H	CF ₃	H	H	C ₃ H ₇
529	H	CF ₃	H	H	C ₆ H ₁₃
530	H	OCF ₃	H	H	CH ₃
531	H	OCF ₃	H	H	C ₃ H ₇
532	H	OCF ₃	H	H	C ₅ H ₁₁

- 75 -

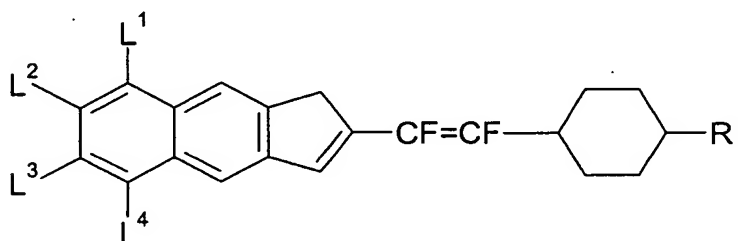
Example	L ¹	L ²	L ³	L ⁴	R
533	H	CF ₃	F	H	C ₂ H ₅
534	H	CF ₃	F	H	C ₃ H ₇
535	H	CF ₃	F	H	C ₆ H ₁₃
536	H	OCF ₃	F	H	CH ₃
537	H	OCF ₃	F	H	C ₃ H ₇
538	H	OCF ₃	F	H	C ₅ H ₁₁
539	H	CF ₃	CF ₃	H	C ₂ H ₅
540	H	CF ₃	CF ₃	H	C ₃ H ₇
541	H	CF ₃	CF ₃	H	C ₆ H ₁₃
542	H	CF ₃	OCF ₃	H	CH ₃
543	H	CF ₃	OCF ₃	H	C ₃ H ₇
544	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
545	H	OCF ₃	OCF ₃	H	C ₂ H ₅
546	H	OCF ₃	OCF ₃	H	C ₃ H ₇
547	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 548 to 577

Example	L ¹	L ²	L ³	L ⁴	R
548	H	F	H	H	CH ₃
549	H	F	H	H	C ₃ H ₇
550	H	F	H	H	C ₅ H ₁₁
551	H	F	F	H	C ₂ H ₅
552	H	F	F	H	C ₃ H ₇
553	H	F	F	H	C ₆ H ₁₃
554	F	F	F	F	CH ₃
555	F	F	F	F	C ₃ H ₇
556	F	F	F	F	C ₅ H ₁₁
557	H	CF ₃	H	H	C ₂ H ₅
558	H	CF ₃	H	H	C ₃ H ₇
559	H	CF ₃	H	H	C ₆ H ₁₃
560	H	OCF ₃	H	H	CH ₃
561	H	OCF ₃	H	H	C ₃ H ₇
562	H	OCF ₃	H	H	C ₅ H ₁₁
563	H	CF ₃	F	H	C ₂ H ₅
564	H	CF ₃	F	H	C ₃ H ₇
565	H	CF ₃	F	H	C ₆ H ₁₃
566	H	OCF ₃	F	H	CH ₃
567	H	OCF ₃	F	H	C ₃ H ₇
568	H	OCF ₃	F	H	C ₅ H ₁₁
569	H	CF ₃	CF ₃	H	C ₂ H ₅
570	H	CF ₃	CF ₃	H	C ₃ H ₇
571	H	CF ₃	CF ₃	H	C ₆ H ₁₃

- 77 -

Example	L ¹	L ²	L ³	L ⁴	R
572	H	CF ₃	OCF ₃	H	CH ₃
573	H	CF ₃	OCF ₃	H	C ₃ H ₇
574	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
575	H	OCF ₃	OCF ₃	H	C ₂ H ₅
576	H	OCF ₃	OCF ₃	H	C ₃ H ₇
577	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 578 to 607

Example	L ¹	L ²	L ³	L ⁴	R
578	H	F	H	H	CH ₃
579	H	F	H	H	C ₃ H ₇
580	H	F	H	H	C ₅ H ₁₁
581	H	F	F	H	C ₂ H ₅
582	H	F	F	H	C ₃ H ₇
583	H	F	F	H	C ₆ H ₁₃
584	F	F	F	F	CH ₃
585	F	F	F	F	C ₃ H ₇
586	F	F	F	F	C ₅ H ₁₁
587	H	CF ₃	H	H	C ₂ H ₅
588	H	CF ₃	H	H	C ₃ H ₇
589	H	CF ₃	H	H	C ₆ H ₁₃
590	H	OCF ₃	H	H	CH ₃
591	H	OCF ₃	H	H	C ₃ H ₇
592	H	OCF ₃	H	H	C ₅ H ₁₁
593	H	CF ₃	F	H	C ₂ H ₅

- 78 -

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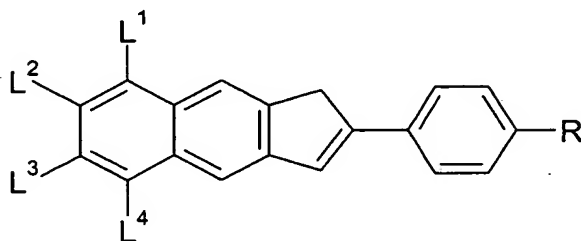
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Example	L ¹	L ²	L ³	L ⁴	R
594	H	CF ₃	F	H	C ₃ H ₇
595	H	CF ₃	F	H	C ₆ H ₁₃
596	H	OCF ₃	F	H	CH ₃
597	H	OCF ₃	F	H	C ₃ H ₇
598	H	OCF ₃	F	H	C ₅ H ₁₁
599	H	CF ₃	CF ₃	H	C ₂ H ₅
600	H	CF ₃	CF ₃	H	C ₃ H ₇
601	H	CF ₃	CF ₃	H	C ₆ H ₁₃
602	H	CF ₃	OCF ₃	H	CH ₃
603	H	CF ₃	OCF ₃	H	C ₃ H ₇
604	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
605	H	OCF ₃	OCF ₃	H	C ₂ H ₅
606	H	OCF ₃	OCF ₃	H	C ₃ H ₇
607	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 608 to 637

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Example	L ¹	L ²	L ³	L ⁴	R
608	H	F	H	H	CH ₃
609	H	F	H	H	C ₃ H ₇
610	H	F	H	H	C ₅ H ₁₁
611	H	F	F	H	C ₂ H ₅
612	H	F	F	H	C ₃ H ₇
613	H	F	F	H	C ₆ H ₁₃
614	F	F	F	F	CH ₃
615	F	F	F	F	C ₃ H ₇

- 79 -

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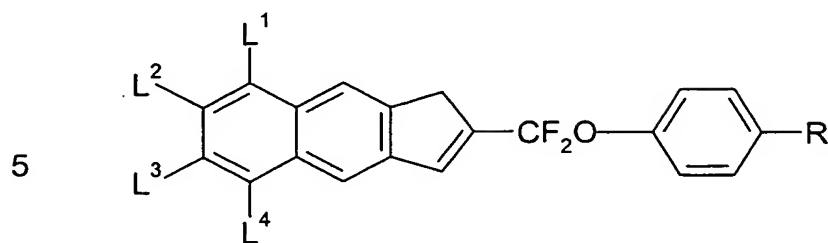
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Example	L ¹	L ²	L ³	L ⁴	R
616	F	F	F	F	C ₅ H ₁₁
617	H	CF ₃	H	H	C ₂ H ₅
618	H	CF ₃	H	H	C ₃ H ₇
619	H	CF ₃	H	H	C ₆ H ₁₃
620	H	OCF ₃	H	H	CH ₃
621	H	OCF ₃	H	H	C ₃ H ₇
622	H	OCF ₃	H	H	C ₅ H ₁₁
623	H	CF ₃	F	H	C ₂ H ₅
624	H	CF ₃	F	H	C ₃ H ₇
625	H	CF ₃	F	H	C ₆ H ₁₃
626	H	OCF ₃	F	H	CH ₃
627	H	OCF ₃	F	H	C ₃ H ₇
628	H	OCF ₃	F	H	C ₅ H ₁₁
629	H	CF ₃	CF ₃	H	C ₂ H ₅
630	H	CF ₃	CF ₃	H	C ₃ H ₇
631	H	CF ₃	CF ₃	H	C ₆ H ₁₃
632	H	CF ₃	OCF ₃	H	CH ₃
633	H	CF ₃	OCF ₃	H	C ₃ H ₇
634	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
635	H	OCF ₃	OCF ₃	H	C ₂ H ₅
636	H	OCF ₃	OCF ₃	H	C ₃ H ₇
637	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

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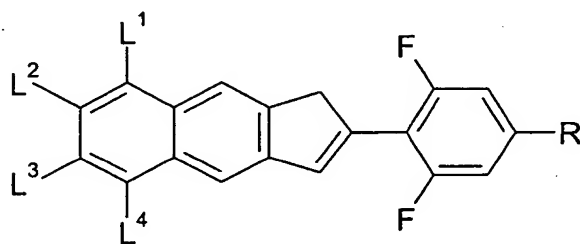
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Examples 638 to 667

Example	L ¹	L ²	L ³	L ⁴	R
638	H	F	H	H	CH ₃
639	H	F	H	H	C ₃ H ₇
640	H	F	H	H	C ₅ H ₁₁
641	H	F	F	H	C ₂ H ₅
642	H	F	F	H	C ₃ H ₇
643	H	F	F	H	C ₆ H ₁₃
644	F	F	F	F	CH ₃
645	F	F	F	F	C ₃ H ₇
646	F	F	F	F	C ₅ H ₁₁
647	H	CF ₃	H	H	C ₂ H ₅
648	H	CF ₃	H	H	C ₃ H ₇
649	H	CF ₃	H	H	C ₆ H ₁₃
650	H	OCF ₃	H	H	CH ₃
651	H	OCF ₃	H	H	C ₃ H ₇
652	H	OCF ₃	H	H	C ₅ H ₁₁
653	H	CF ₃	F	H	C ₂ H ₅
654	H	CF ₃	F	H	C ₃ H ₇
655	H	CF ₃	F	H	C ₆ H ₁₃
656	H	OCF ₃	F	H	CH ₃
657	H	OCF ₃	F	H	C ₃ H ₇
658	H	OCF ₃	F	H	C ₅ H ₁₁
659	H	CF ₃	CF ₃	H	C ₂ H ₅
660	H	CF ₃	CF ₃	H	C ₃ H ₇
661	H	CF ₃	CF ₃	H	C ₆ H ₁₃

- 81 -

Example	L ¹	L ²	L ³	L ⁴	R
662	H	CF ₃	OCF ₃	H	CH ₃
663	H	CF ₃	OCF ₃	H	C ₃ H ₇
664	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
665	H	OCF ₃	OCF ₃	H	C ₂ H ₅
666	H	OCF ₃	OCF ₃	H	C ₃ H ₇
667	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 668 to 697

Example	L ¹	L ²	L ³	L ⁴	R
668	H	F	H	H	CH ₃
669	H	F	H	H	C ₃ H ₇
670	H	F	H	H	C ₅ H ₁₁
671	H	F	F	H	C ₂ H ₅
672	H	F	F	H	C ₃ H ₇
673	H	F	F	H	C ₆ H ₁₃
674	F	F	F	F	CH ₃
675	F	F	F	F	C ₃ H ₇
676	F	F	F	F	C ₅ H ₁₁
677	H	CF ₃	H	H	C ₂ H ₅
678	H	CF ₃	H	H	C ₃ H ₇
679	H	CF ₃	H	H	C ₆ H ₁₃
680	H	OCF ₃	H	H	CH ₃
681	H	OCF ₃	H	H	C ₃ H ₇
682	H	OCF ₃	H	H	C ₅ H ₁₁
683	H	CF ₃	F	H	C ₂ H ₅

- 82 -

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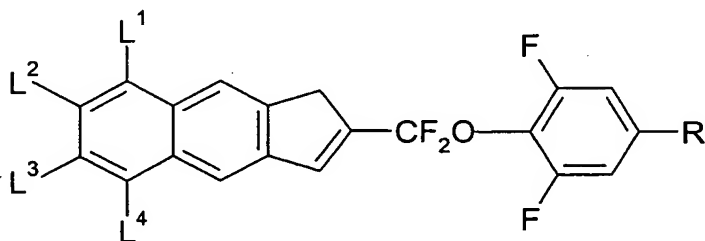
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Example	L ¹	L ²	L ³	L ⁴	R
684	H	CF ₃	F	H	C ₃ H ₇
685	H	CF ₃	F	H	C ₆ H ₁₃
686	H	OCF ₃	F	H	CH ₃
687	H	OCF ₃	F	H	C ₃ H ₇
688	H	OCF ₃	F	H	C ₅ H ₁₁
689	H	CF ₃	CF ₃	H	C ₂ H ₅
690	H	CF ₃	CF ₃	H	C ₃ H ₇
691	H	CF ₃	CF ₃	H	C ₆ H ₁₃
692	H	CF ₃	OCF ₃	H	CH ₃
693	H	CF ₃	OCF ₃	H	C ₃ H ₇
694	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
695	H	OCF ₃	OCF ₃	H	C ₂ H ₅
696	H	OCF ₃	OCF ₃	H	C ₃ H ₇
697	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

Examples 698 to 727

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Example	L ¹	L ²	L ³	L ⁴	R
698	H	F	H	H	CH ₃
699	H	F	H	H	C ₃ H ₇
700	H	F	H	H	C ₅ H ₁₁
701	H	F	F	H	C ₂ H ₅
702	H	F	F	H	C ₃ H ₇
703	H	F	F	H	C ₆ H ₁₃
704	F	F	F	F	CH ₃
705	F	F	F	F	C ₃ H ₇

- 83 -

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Example	L ¹	L ²	L ³	L ⁴	R
706	F	F	F	F	C ₅ H ₁₁
707	H	CF ₃	H	H	C ₂ H ₅
708	H	CF ₃	H	H	C ₃ H ₇
709	H	CF ₃	H	H	C ₆ H ₁₃
710	H	OCF ₃	H	H	CH ₃
711	H	OCF ₃	H	H	C ₃ H ₇
712	H	OCF ₃	H	H	C ₅ H ₁₁
713	H	CF ₃	F	H	C ₂ H ₅
714	H	CF ₃	F	H	C ₃ H ₇
715	H	CF ₃	F	H	C ₆ H ₁₃
716	H	OCF ₃	F	H	CH ₃
717	H	OCF ₃	F	H	C ₃ H ₇
718	H	OCF ₃	F	H	C ₅ H ₁₁
719	H	CF ₃	CF ₃	H	C ₂ H ₅
720	H	CF ₃	CF ₃	H	C ₃ H ₇
721	H	CF ₃	CF ₃	H	C ₆ H ₁₃
722	H	CF ₃	OCF ₃	H	CH ₃
723	H	CF ₃	OCF ₃	H	C ₃ H ₇
724	H	CF ₃	OCF ₃	H	C ₅ H ₁₁
725	H	OCF ₃	OCF ₃	H	C ₂ H ₅
726	H	OCF ₃	OCF ₃	H	C ₃ H ₇
727	H	OCF ₃	OCF ₃	H	C ₆ H ₁₃

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